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POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL: Southam Building | LONDON, ENG.: 88 Fleet Street, E.C. | WINNIPEG: 901 Confederation Life Building

Vol. XV.—No. 1. | Publication Office, Toronto—Jan. 5, 1922 | Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Jenkins Valves for Every Service

They Stand The Test

The Jenkins Trade Mark is a guarantee of valve satisfaction.

TRADE JENKINS MARK

Jenkins Bros

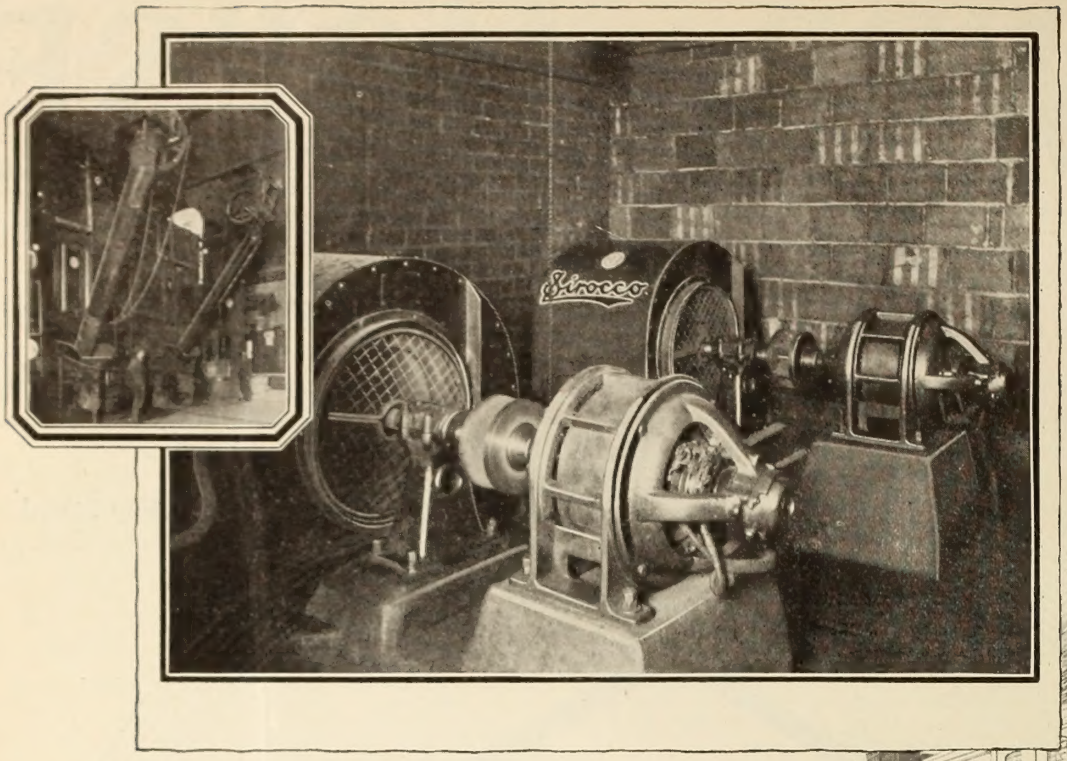
There are many inferior imitations of the genuine Jenkins. You'll know the genuine by the name Jenkins within a diamond mark cast on the valve body.

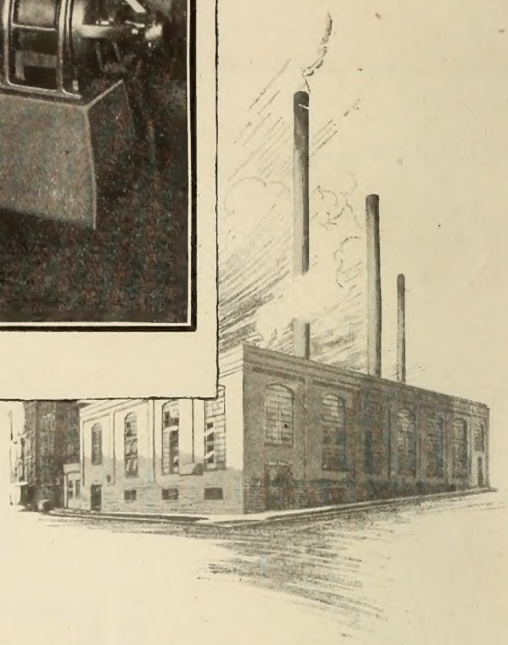
Write for Catalog No. 8.

Fig. 300
JENKINS
Brass Gate Valve
Type "K"

Jenkins Bros.
LIMITED
Head Office and Works: 103 St. Remi St. Montreal, Can.
TORONTO WINNIPEG VANCOUVER
European Branch 6 Great Queen St. Kingsway, London, W.C.2, Eng.
Agencies in all the principal countries of the world

Fig. 106
JENKINS
Brass Globe Valve
Standard Pattern





Making Every Pound of Your Coal Count

Thorough combustion of fuel is assured with "Sirocco" Mechanical Draft Fans. And getting the utmost of heat units out of every pound of coal with "Sirocco" equipment helps insure economical operation of the power plant.

Operated with automatic stokers, "Sirocco" Fans (forced or induced) are helping to reduce the fuel bills of hundreds of public service corporations.

Our engineers are particularly well qualified to cooperate with you in selecting the right kind of Mechanical Fans. Write for descriptive bulletin.

Canadian Sirocco Company, Ltd., Windsor, Ont.

"Sirocco" Products

BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

Carrying High Overratings on Natural Draft

Boiler ratings as high as 200% can be carried with poor quality, high ash and badly clinkering coals, on natural draft, when the boilers are equipped with

FILES HAND STOKERS

They insure clean fires all the time, without necessitating slicing, poking through open fire doors. Moving a few convenient levers mounted on the boiler fronts sifts the ashes, cleans the fire, breaks up all clinker and dumps the refuse into the pit. The labor saving is nearly as great as the coal saving.

The illustration shows a typical Files installation. Files stokers are also furnished with mechanical feed where plant is equipped for it.

Write for full particulars on the Files now.

Waterous

BRANTFORD, ONTARIO, CANADA

WASTED ENERGY

At first glance, the connection between a boiler explosion and a leaking stuffing-box might not be apparent.

The final result, however, whether by a sudden release of energy, or a slow, steady leak, is the same, —heat energy wasted that would otherwise do useful work on the piston.

A loss that can be avoided by the use of a "live" well lubricated packing, securing a leakless stuffing-box with minimum friction and maintaining a glass-like polish on the rod.

For high pressure and superheat try GARLOCK style No. 446 and "Spare the rod."

GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY
HAMILTON, ONTARIO

MONTREAL, QUE. — *Branches* — CALGARY, ALTA.
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BOWSER
ESTABLISHED 1885
PISTON-TYPE MEASURING PUMPS

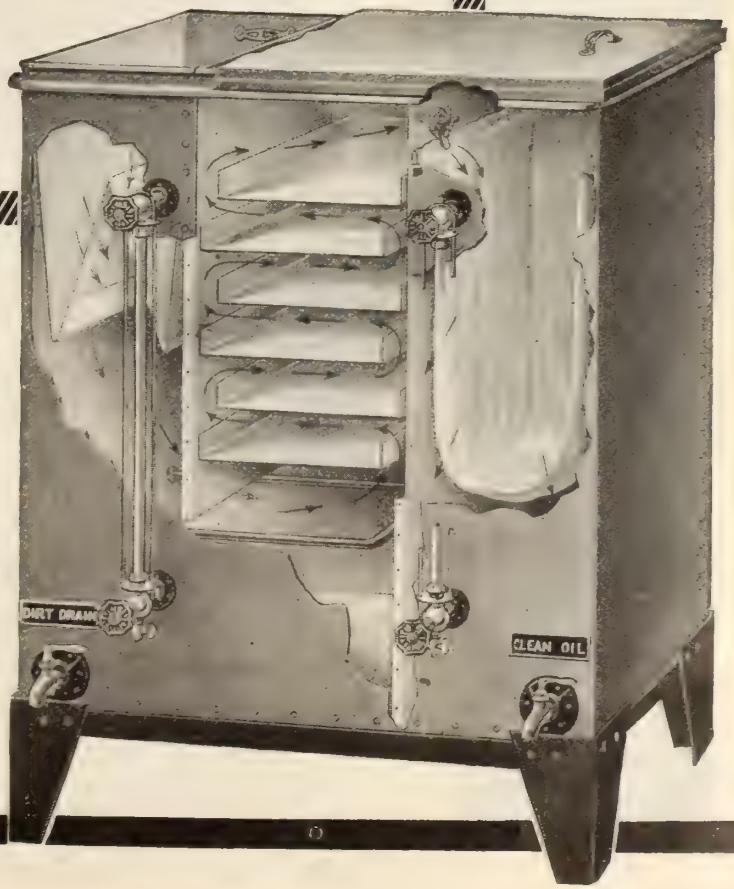
THE LIFE BLOOD OF THE FACTORY

Dirty, gritty lubricating oil will junk your machinery long before its time. **Friction is production's worst enemy,** and wear and tear caused by dirt and grit in oil slowly but surely wears out expensive bearings and other machinery parts.

Clean oil prolongs the life of machinery. Bowser Lubricating and Filtering Systems assure clean filtered oil on all bearings and restore the oil to its original lubricating quality. Try the Bowser Perfected Process of Seepage Filtration.

Installation takes a minimum of floor space.

There is a Bowser System for every oil filtration requirement. Also complete oil storage and handling equipment.



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—BY—

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QUALITY

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"PALMETTO"

REG U S PAT OFFICE

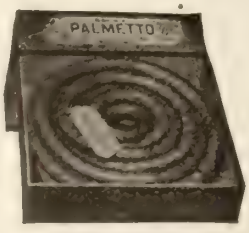
Packing

Rests upon the solid foundation of quality

Made of a grade of material usually considered too good for packing purposes.

However, years of experience have proven that it's this unusual quality that causes "Palmetto" to give longer service than other packings, especially under extreme conditions.

"PALMETTO" is a practically frictionless packing, as it carries an unusual quantity and quality of graphite grease lubricant—keeps the rod perfectly lubricated.



If you don't know "Palmetto" let us convince you with a working sample to test for yourself—no charge.

Let us know the size you can test.

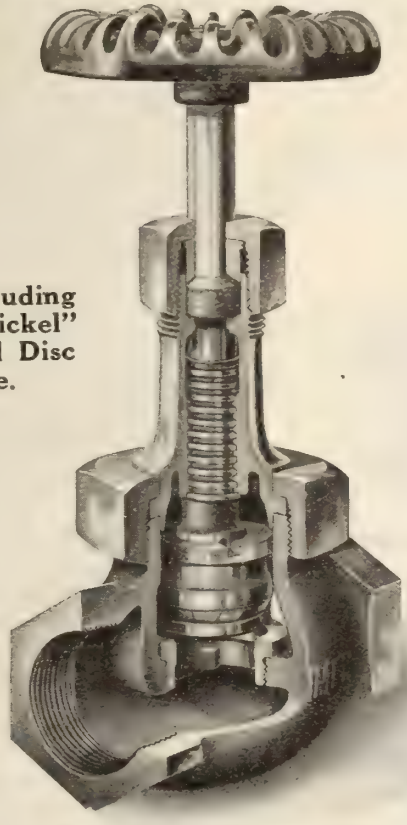
GREENE, TWEED & CO.

Sole Manufacturers

109 DUANE STREET, NEW YORK

CANADIAN AGENTS:—The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

LUNKENHEIMER "Renewo" Valves



All parts including the "Valve-nickel" Seat-ring and Disc are renewable.

Seating surfaces are regrindable.

Medium Pat., Fig. 73.
Extra Heavy, Fig. 16.

Specified by engineers seeking the highest degree of efficiency in operation and maintenance because **"Renewo"** service records are proof positive of their unparalleled value for power plant use.

Users realize there is no substitute for **"Renewo"** excellence — their wear resistance, permanence in the line and low upkeep cost all contributing to economy — the essential to successful plant operation.

The broad scope of the line, including Globe, Angle and Cross, Straightway or Y, and Horizontal and Angle Check Valves, for pressures up to 200 and 300 pounds, covers every requirement.

Carried in stock for immediate delivery by Lunkenheimer Distributors situated in every commercial center. Specify **"Renewo"** Valves and insist on getting what you specify.

Write for catalog No. 58-DC.

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"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
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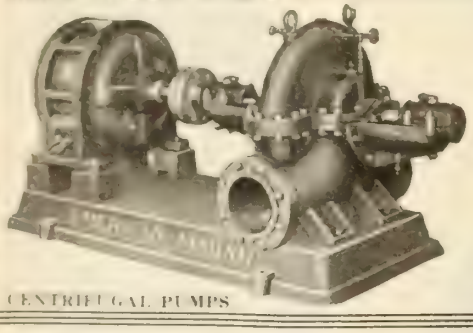
PUMPS

This ancient pumping device was only used for local irrigation.

The Egyptian "taaboot"—or barrelmill—is a very curious pumping device. It consists of a long wooden tube, containing a spiral or screw, made of thin wooden laths. As the operator turned the crank, the screw revolved, and literally "screwed" the water out of the river.

One good thing about the barrelmill: It is reliable. The same may be said—in a much more meaningful way—of modern American-Marsh Centrifugal Pumps. These Pumps are made in both single and double suction, solid and split case patterns. Write for Bulletins.

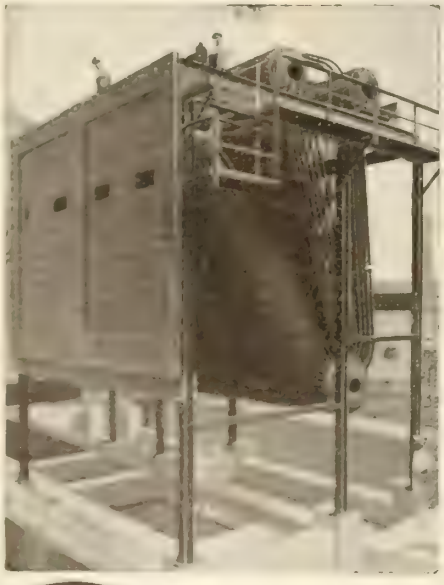


CENTRIFUGAL PUMPS

American Steam Pump Co.

Battle Creek, Michigan

CANADIAN AGENTS—A. R. Williams Machinery Co., Ltd., Toronto. Williams & Wilson, Ltd., Montreal. London Engine Supplies Co., Ltd., London. A. R. Williams Machinery Co., Ltd., Winnipeg. Mechanics' Supply Co., Ltd., Quebec. Gorman's Ltd., Edmonton and Calgary.
The American Marsh Lines also include Power Pumps, Compressors, Vacuum Pumps, Condensers, Deep Well Engines, Boiler Feed Pumps



Connelly Water Tube Boilers

are of the 4-drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H. P. up to 4,000 H.P. and for working pressures up to 300 lbs. per sq. in. Over 150,000 H.P. in successful operation.

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AGENTS

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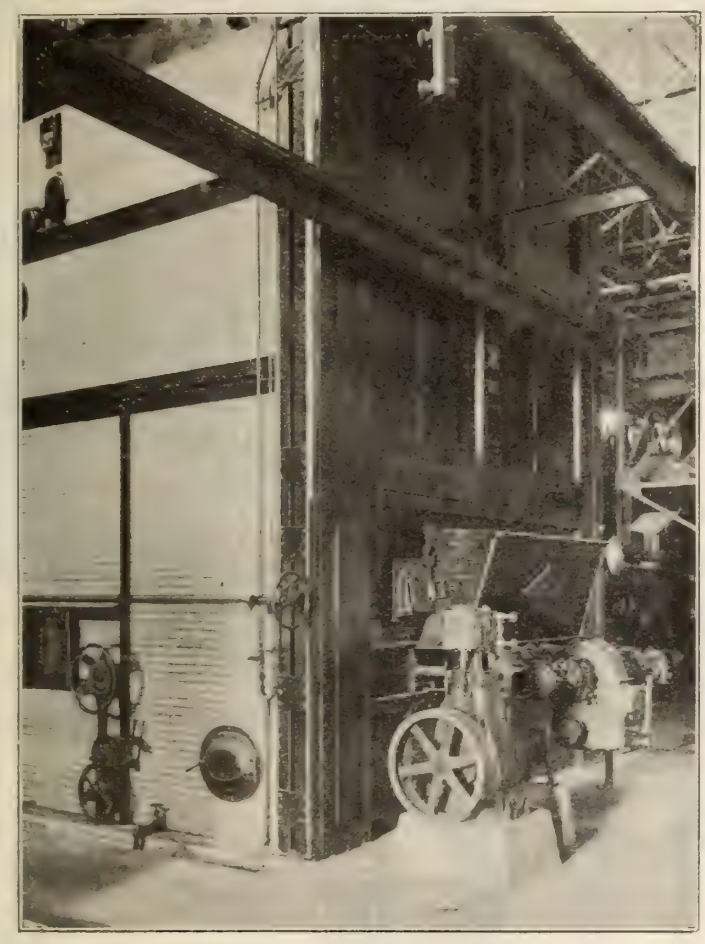
ESTABLISHED 1834

LEONARD

One-Third Less Coal

A large enough saving to interest any power plant manager when every possible means is being used to reduce costs.



"The picture shows one of seven new boilers being installed in the Main Pumping Station of the Waterworks Department, on Eastern Avenue. It is the first of the seven to be completed. Waterworks Superintendent J. A. Hiller declares that the new boilers will save the city $40,000 in the cost of the operating plant. New boilers already in service at the River Pumping Station, California, O., are operating on one-third less coal than was used at that plant with the old boilers."

From *Cincinnati Times-Star*—October 26, 1921

AT the California Station of the Cincinnati Water-Works the new equipment is operating on one-third less coal than was used with the old.

(Note clipping from Cincinnati *Times-Star* below.)

At this station 4-retort

RILEY UNDERFEED STOKERS

fire four 420 h.p. Stirling boilers, furnishing steam for operating the pumps. This equipment was installed under the direction of C. H. Anderson, Mechanical Engineer.

The Riley Stoker effects maximum saving in fuel and labor because it is practically automatic in all its functions. A distinctive feature, the reciprocating retort sides, not only increase efficiency by greatly intensifying combustion, but automatically break up clinkers while the rocker dump continuously discharges the refuse.

Send for the Riley Stoker Catalog, it will show you how to save fuel and labor, two of the most vital factors in your plant.

The Sanford Riley Stoker Company is now prepared to equip new Riley Stokers with coal agitators licensed under the Negus--Tiffany patents.

"A type to meet every stoker need"

SANFORD RILEY STOKER CO.
WORCESTER, MASS
RILEY UNDERFEED STOKERS

TRADE MARK Rx REGISTERED

MURPHY IRON WORKS
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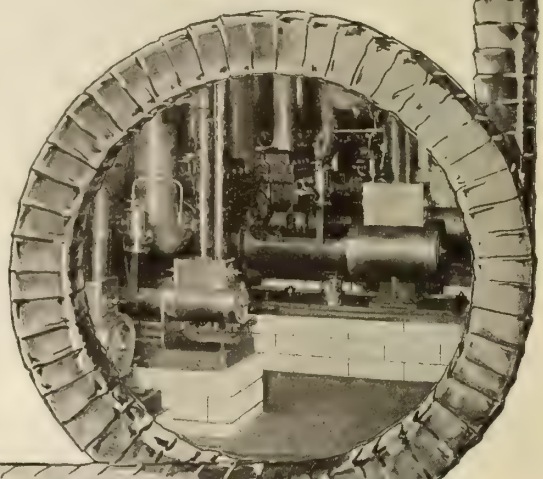
John Crane

Eight Years of Packing Service
JOHN CRANE Flexible Metallic Packing Shows Greatest Results in Constant Service

Eight years ago Chief Engineer, N. Gross, of the Standard Oil Building, Chicago, installed JOHN CRANE Flexible Metallic Packing in the boiler-feed pump pictured below. Mr. Gross reports packing and pump in good order after eight years and has standardized JOHN CRANE on all service.

JOHN CRANE holds this long service record because of its scientific, practical construction. Made of babbitt foil and graphite, it brings Packing science "The Babbitt-bearing Principle," and while responding to the slightest pressure of the gland never dries out, but remains compressible and will not score rods.

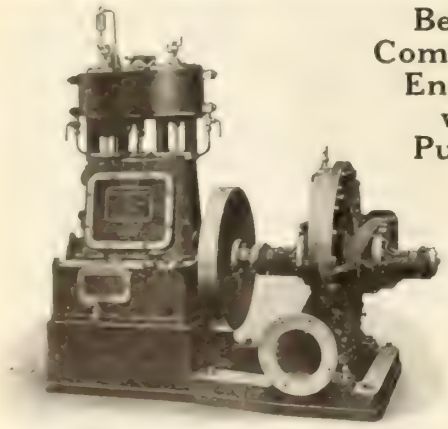


Write for your copy of "THE ANSWER" a book that tells unusually interesting things about packing problems

The R. C. MILLER OIL & SUPPLY CO.

38 & 40 YOUVILLE SQUARE, MONTREAL

Belliss Compound Engine with Pump



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Electrically Operated Freight Truck for General Industrial Haulage
It will reduce labor costs
It will do the work of 10 men
It will stand rough usage
It can be operated by unskilled labor

Agents:

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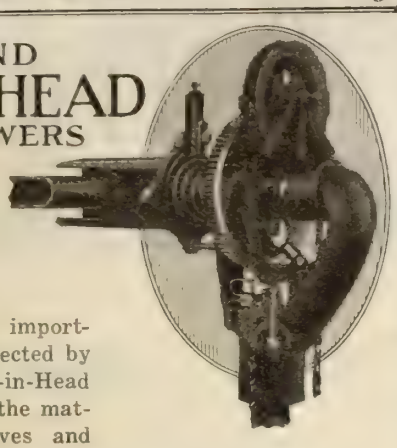
Saving 50 to 66% in the Cost of Pipe Valves and Fittings

DIAMOND
VALV-IN-HEAD
SOOT BLOWERS



One of the most important economies effected by the Diamond Valv-in-Head soot blower is in the matter of pipe, valves and fittings on new installations. A saving is made of practically two-thirds in the actual length of pipe required. The elimination of expensive individual control valves in favor of the Valv-in-Head is an important cost consideration. This decreases the initial cost of these items by one-half to two-thirds, and reduces radiation losses from the soot blower lines proportionately.

On a typical six unit installation, with the independent valve system 83 feet of pipe and six 2 in. individual control valves are required. With the Valv-in-Head only 25 feet of 2 in. pipe and no individual valves are required. With this six unit installation the saving in cost of pipe, valves and fittings effected by the Valv-in-Head system is approximately 64 per cent.

The comparisons are:
Using "Bronze body valves, nickel seats and discs"

Independent valve system	**$249.44**
Valv-in-Head system	**90.83**
Saving by latter	**$158.61**

This is only one of eleven important advantages of Diamond Valv-in-Head soot blowers. Others include savings in steam, labor, maintenance, increase in cleaning efficiency, etc., etc.

From an operating standpoint the Diamond Valv-in-Head soot blower is a tremendously better investment than the independent valve soot blower. Among Valv-in-Head operating economies are:

1. STEAM FOR OPERATION: Saving of 50 per cent.

2. LABOR FOR OPERATION: Saving of 50 per cent.

3. MAINTENANCE: Saving of 25 to 50 per cent.

Once installed Diamond Valv-in-Head soot blowers pay for themselves in a few months.

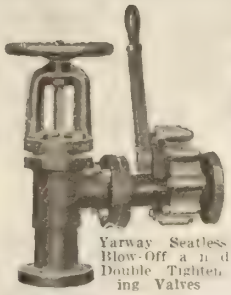
Every Boiler needs a Mechanical Soot Blower and you will save Money by buying the best.

Ask for your copy of Bulletin 287 describing the new soot blower.

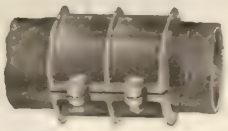
Diamond Specialty Co., Windsor, Ont.

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL



Yarway Seatless Blow-Off and Double Tightening Valves



Holtite Pipe Clamp (Stop holes and splits in pipes)

Yarway Pipe Joint Clamp

Yarway Unloader

1908 - 1922

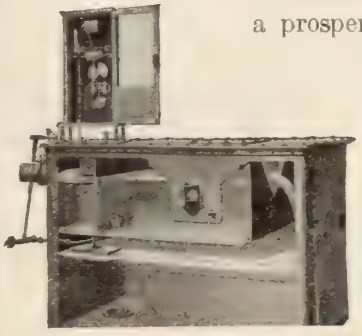
Fourteen Years of Yarway Service

Yarway Adjustable Spray-head

For nearly fourteen years, The Yarway Products have been industriously making new friends—and strengthening those friendships by faithful service; now they can point to the record of promises fulfilled in thousands of plants throughout the world. Users of power plant specialties everywhere have endorsed the policy on which this business is founded--that of performing satisfactory service and giving full value. Their faith has been evidenced by the fact that five out of every six have repeated their first orders.

Yarway Boiler Skimmer

It is our hope and intention to merit the continued confidence of old friends and to have the privilege of making many new friends during 1922. May it be a prosperous year for you!



Yarway-Lea V-Notch Meter

Yarway Hydraulic Valve

·YARNALL·WARING·COMPANY·

7604-20 Queen Street
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Representatives in all Principal Cities
For Complete List of Offices see Sweet's Engineering Catalog-Keystone Mining Catalog or Chemical Catalog

YARWAY SEATLESS BLOW-OFF VALVE··YARWAY DOUBLE TIGHTENING BLOW-OFF VALVE··YARWAY BOILER SKIMMER··YARWAY ADJUSTABLE SPRAY HEAD··YARWAY HYDRAULIC VALVE··YARWAY UNLOADER YARWAY-LEA V-NOTCH METER··YARWAY PIPE CLAMPS·ETC.

YARWAY
POWER PLANT DEVICES

LINDE

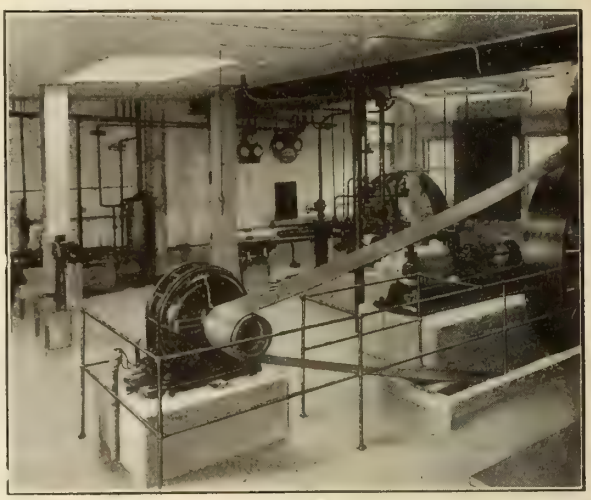
Made in Canada

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

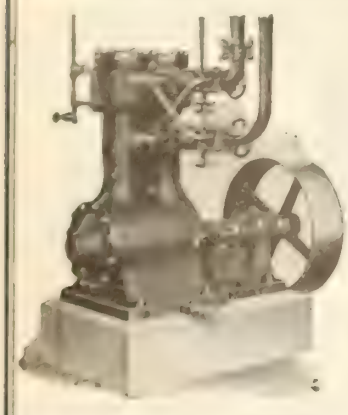


This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL,

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

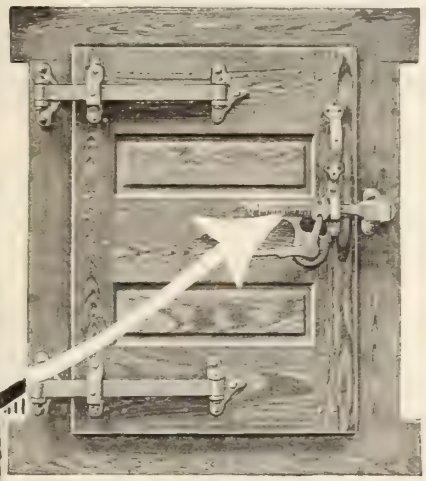
242 Beecher St. - - - Milwaukee, Wisconsin

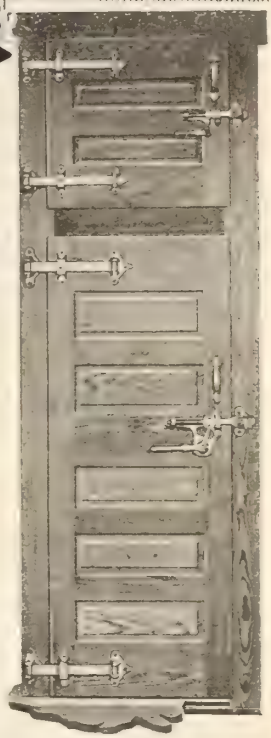
JAMISON

Formerly "JONES"

Heavy Duty Cold Storage Doors

In the **Jamison** line of cold storage doors you can get a door exactly suited to your requirements. Made for all conditions and purposes.





Shown here is our Standard Bunker Door—also our Entrance and Bunker Door combined. Special attention is drawn toward the Automatic Self-tightening Fastener and Adjustable Spring Hinges. They are heavier in construction and combine practical features not found in other doors. All hardware in Jamison doors is bolted to the door and frame; no wood screws used.

These are but a few of the features that have won for **Jamison** products the reputation of the **World's Standard** by their long, unfailing performance under all conditions.

Catalogue No. 10 gives complete details—shall we send it?

JAMISON COLD STORAGE DOOR CO.

Formerly

JONES COLD STORE DOOR COMPANY

HAGERSTOWN, MD.
U.S.A.

P&H WROUGHT PIPE BENDS
AND FLANGED PIPE JOINTS

ALL KINDS AND SIZES UP TO 10" DIAMETER

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

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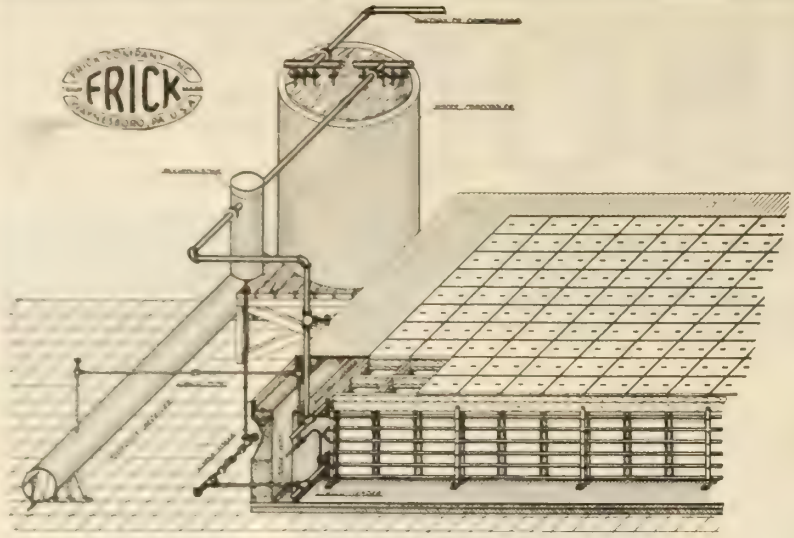


The FRICK FLOODED SYSTEM

Is a STANDARD Part of Every FRICK Plant

Its simplicity and dependability have made it a standard known the world over. Its success is unqualified.

It

Simplifies plant operation by reducing the number of feed valves to be regulated.
Increases plant efficiency by insuring uniform operation and giving absolute control of the ammonia.
Adds to plant safety by preventing priming accidents.
Lowers first cost of plant by increasing the heat transfer through the evaporating surface, thus reducing the amount of surface required.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

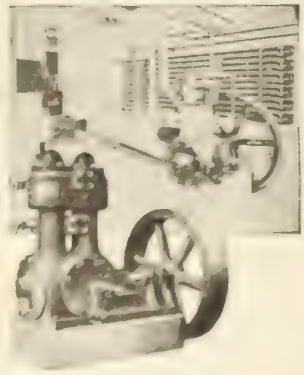
Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose —all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal.

A YORK MACHINE

does not require a skilled operator



DON'T get the impression that Mechanical Refrigeration means complicated apparatus, difficult to understand and costly to operate. You need have no such fears if it's a YORK installation.

A York plant is the embodiment of simple efficiency. No skilled attendant is required. One of our customers says in testifying to the simplicity of his York plant, "It is being operated successfully by an employee who, prior to the installation of the machine, had never seen one nor had any experience in operating one."

Constant attention is unnecessary. The simple regulation of one valve gives any degree of cold you want—freezing, zero, below zero—whatever your business needs may require.

If you want the simplest, most efficient, most economical refrigerating system, you will investigate the York Refrigerating Plant.

Canadian Representative:
CANADIAN ICE MACHINE COMPANY
TORONTO: Villiers and Munition Sts., Eastern Harbor Terminals
MONTREAL .....324 Craig St. West
WINNIPEG 60 Lombard St.

YORK MANUFACTURING COMPANY

(Ice Making and Refrigerating Machinery Exclusively)

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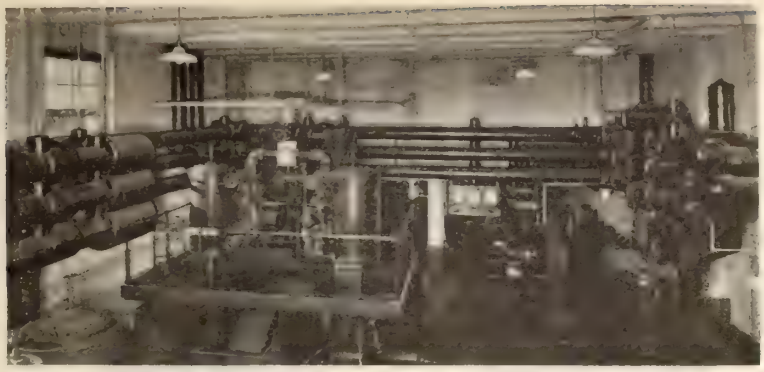

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—To protect the competent engineer and his vocation.
—To enroll all competent engineers in this organization.
—To impart information beneficial to the profession.
—To assist members out of employment to obtain the same.
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—The belief that knowledge and ability of one's profession is what is necessary to make success possible.

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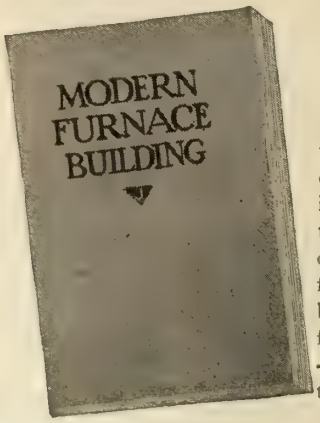

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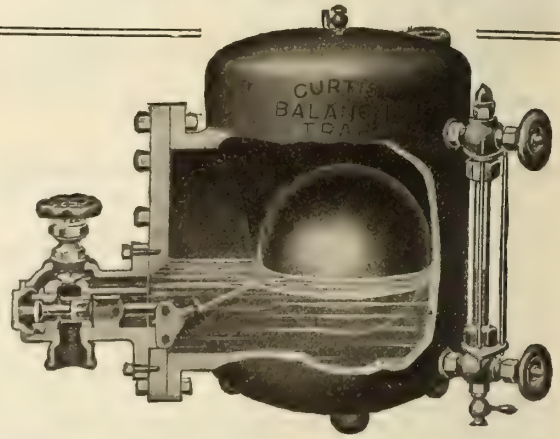

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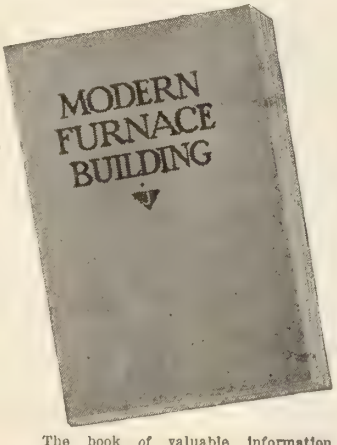

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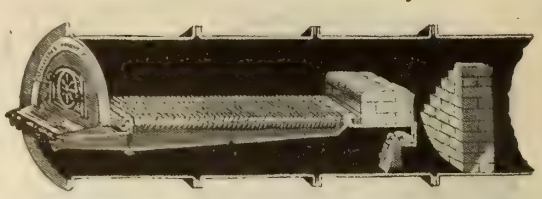

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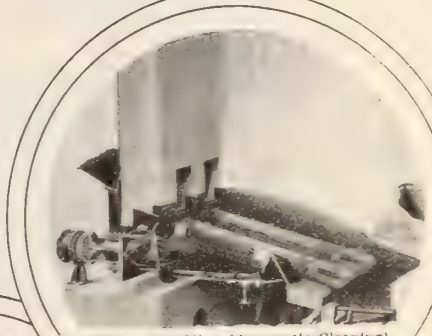

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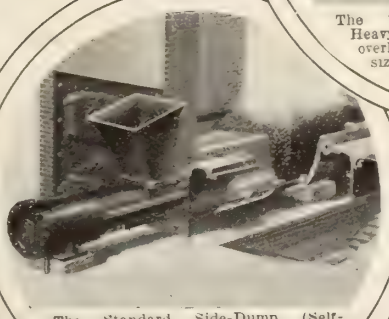

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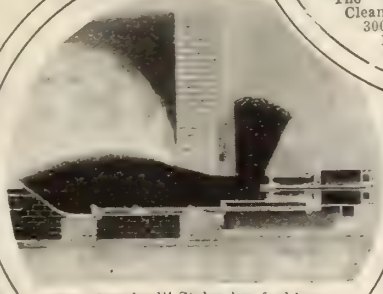

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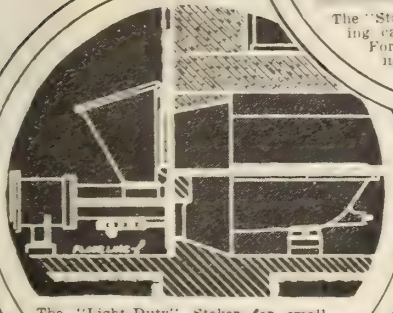

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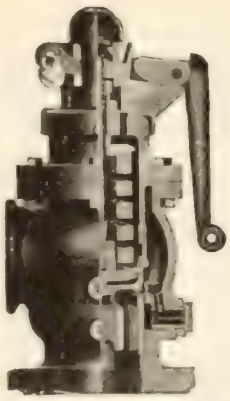
Safety Pop Valves

are judged



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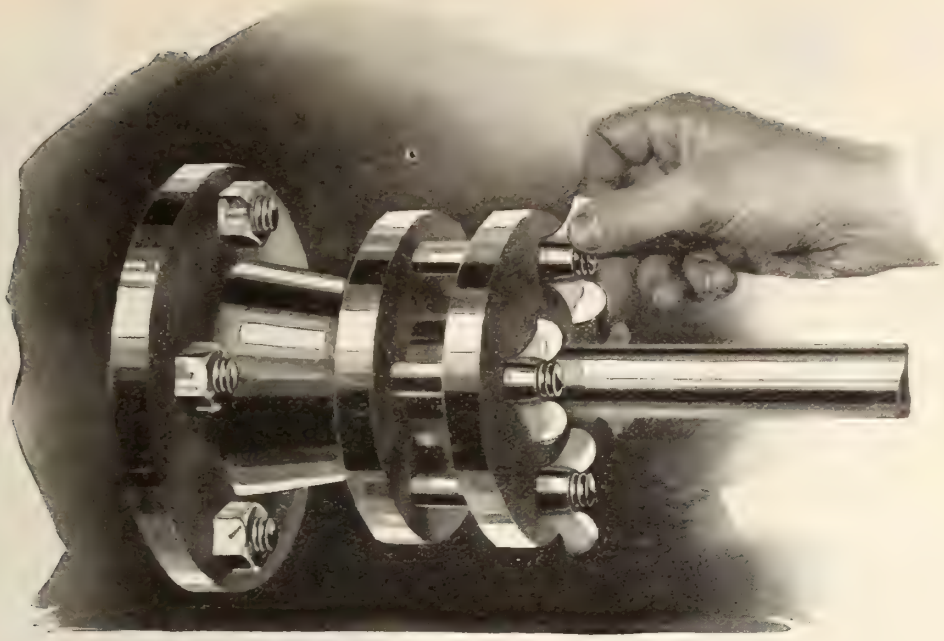

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Points of this G. & McC. Co. Machine that should be remembered are:

—The Turbine is entirely automatic.
—No oil or grease cups.
—Stuffing boxes and glands seldom require attention.
—Emergency governor and valve are entirely separate from main governor and valve.
—Interior may be easily inspected.
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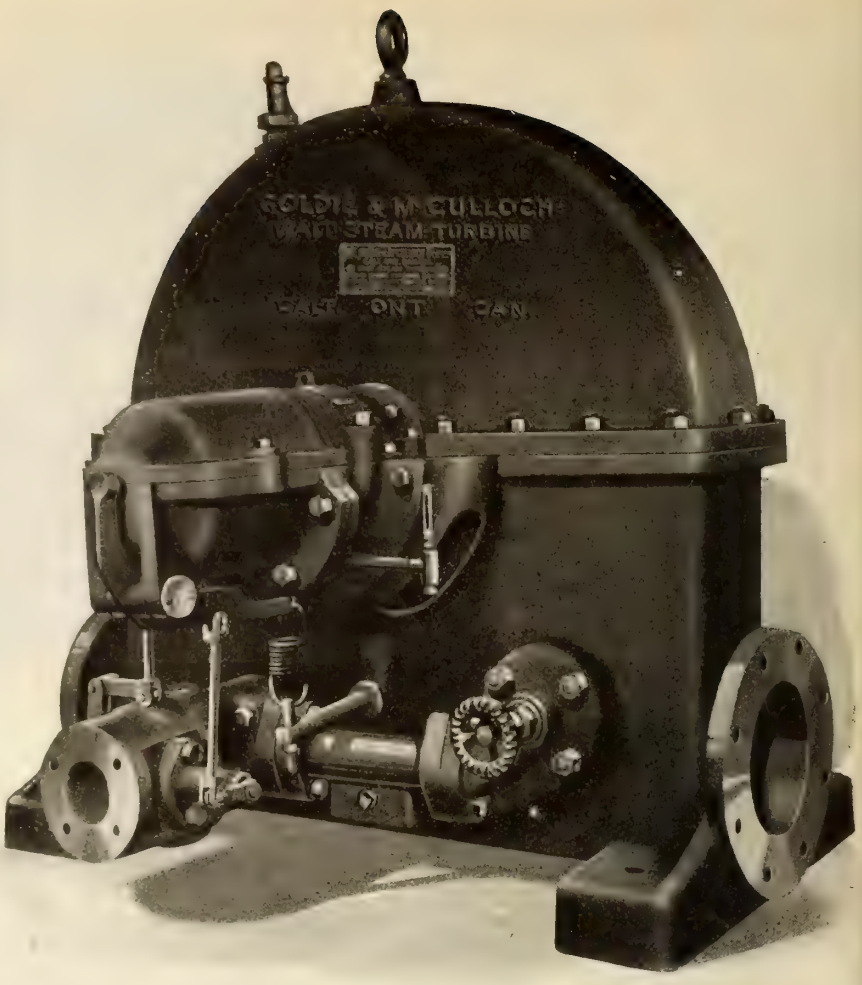

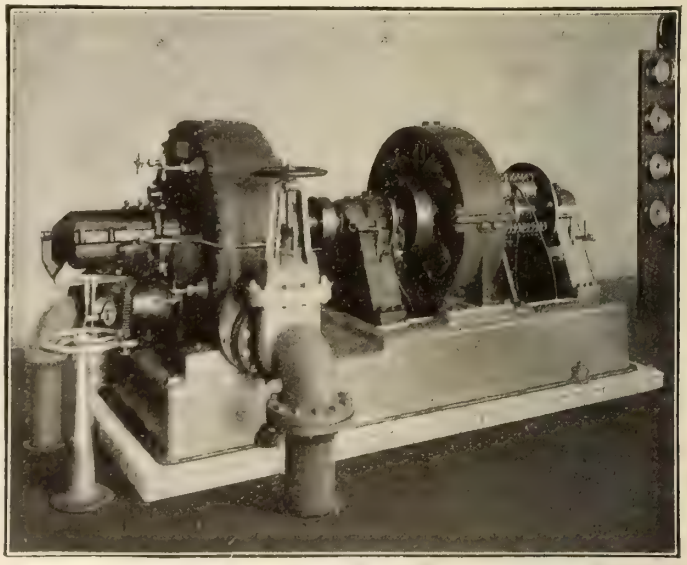

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POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

How to Make a Boiler Evaporation Test

This Interesting Test, Which Is Looked on With a Good Deal of Awe by Some Engineers, Is Here Explained in Great Detail—The Ease of Performing It Is Simply Demonstrated

By J. A. McGILLIVRAY

IF THERE is one thing above all others that takes the joy out of the engineer's life it is to have an efficiency man come in over his head to conduct a test. Remember I said "over the engineer's head."

In large power plants, the efficiency man is a part of the chief's organization, or vice versa, and there is no room for misunderstanding and no division of authority. There should not be two roads to the superintendent's office. But in isolated power plants the case is different, and in this article I am to be distinctly understood as referring to the latter.

The mere presence of the efficiency man is detested by many an otherwise reasonable engineer, and it is extremely doubtful whether the efficiency department ever accomplishes any lasting good under such circumstances. There is every opportunity for bad feeling and lack of co-operation. If efficiency methods are to succeed at all they can do so only when the engineer in charge will conscientiously cause to be carried out the suggestions of the efficiency man, granting, of course, that the efficiency man knows his business. Where this is not so, it is time to do one of two things, make the engineer in charge the efficiency man as well, or fire him. If he is half as good an engineer as he usually thinks he is, the former is the correct thing to do and the sooner the engineer who is not now acquainted with efficiency methods realizes that he needs that acquaintance in his business, the better for him.

That is one thing that he can thank the war for, (or blame it for, according to his viewpoint). The experiences of the war and its effect on our industrial institutions have started an efficiency wave on the American continent the like of which was never known in the past, and accomplished in one sweep what a few engineers, widely scattered, had been trying to accomplish for a half century; namely, to bring to the attention of plant owners the importance of "Scientific Boiler Room Practice." The engineer no longer has to prod the manager to supply the instruments that make for "scientific operation" of the plant, they are forthcoming when needed, but the greatest need is for engineers who can use them.

Scientific methods have not been adopted in all plants, and those are the ones that suffer most by comparison with modern standards. There is no need for it to be so, since any man who thinks enough of his profession to wish for better conditions can do a lot to better them at small expense, as I will try to show him. Moreover, it might be well for the engineer of the small plant to remember that it may be a stepping-stone to a larger and more modern one, and that the same rules apply to a 10,000 H.P. plant, as to a 10 H. P.

The Object of the Test

The first thing to consider when making an evaporation test is what the object in view is, and to prepare accordingly. There is no mystery about an evaporation test. While it is the most important of all power plant tests, it is the simplest to carry out. Practically all evaporation tests are carried out according to the rules adopted by the American Society of Mechanical Engineers, and those rules will be our guide in what is to follow.

The Preliminaries

There must be some means of weighing the water fed to the boiler during the test. Figs. 1 to 3 illustrate three equipments, either of which can be made up at little expense. No. 1 will handle a test up to 1200 H.P. and by the addition of another barrel above will handle the water for 1500 H. P. The method of measuring the water is to fill the barrels to the small overflow, having in the meantime found out definitely what weight of water is contained in each barrel when full to the overflow (an ordinary oil cask with a hole below the top hoop will hold approximately 400 lbs.). Each barrel is tallied as it is emptied and the weight calculated every hour.

The arrangement of barrels shown may be made permanent or just temporary as the person using the outfit desires. If kept full of water when not in use, the outfit will last till the cows come home. The most important dimensions are marked in. The frame can be made of wood or steel. The whole thing if neatly made, using "flanged fittings," "quick opening valves," for the lower barrels, and a little paint, can be made really ornamental, as well as useful. As arranged in Fig. 1 there is 6 ft. of headroom for the operator who operates the lower valves, but if desired the lower valves can be operated from the upper platform by levers attached to the "quick opening lower valves." The lower barrels are connected to the feed pump or to the injector as the case may be.

Fig. 2 illustrates an outfit that may be used for testing up to 600 H.P. and can be operated by one man. Fig. 3 will test anything below 100 B.H.P. The arrangement shown in Fig. 3 is the most accurate of the three, but has the disadvantage that the boiler feeding will be intermittent.

For weighing the coal a wheel barrow and a platform scale may be used, or if the coal is handy and does not require wheeling a tub made from part of an oil cask can be used. After providing a tally board for keeping account of the coal, and water, a thermometer in the lower barrel for measuring the feed temperature, we are ready to start the test, as far as equipment is concerned.

The next thing to see to is that the ash pits are clean and the fire clean and make a close estimate of the amount of fire on the grate before commencing the test and have a mark on the gauge glass. To mark the gauge glass tie a piece of string around it, and when ready to go ahead, slip the string up or down to the water level, and this is where the water level must be when the test is completed. It must be endeavored to stop the test under as nearly the exact conditions that existed when starting as possible.

While the draft measurement and flue gas analysis are very important, they are not absolutely essential to the success of the test, since if it is found at the end of the test that the efficiency

of the boiler furnace and grate is good, the flue gas couldn't have been far from what it should be, but we will come to that later.

The information tallied during an evaporation test is as follows, and tallied every hour, we will assume certain quantities, for example:

TEST DATA

1	Data and Results of Boiler Test	
	(Width 12 Length 7')	
	sq. ft.	84
	Heating Surface sq. ft.	5000
3	Date of Test .....Nov. 14, 1920	
4	Duration of Test .....Hours	8
5	Kind and Size of Coal (Bituminous R.O.M.)	
6	Steam Pressure by Gauge (ave.) per lbs.	150
7	Temperature of Feed Water...Deg. F.	60
8	% Moisture in Steam or (deg. superheat) moisture	3%
9	% Moisture in Coal .....moisture	7%
10	Dry Coal per hour .....lbs.	1860
11	Dry Coal per sq. ft. of Grate surface per Hr. .....lbs.	22.14
12	Equivalent Evap. per hr. from and at 212 deg. F. .....lbs.	16,331
13	Equivnlent Evap. per hr. from and at 212 deg. F. .....lbs. per sq. ft. of heating surface	3.266
14	Rated capacity per hr. from and at 212 deg. F. ..... lbs.	17,250
15	% Rated capacity developed.....	94.7%
16	Equivalent evap. from at 212 deg. per lb dry coal .....lbs.	8.9
17	Equivalent evap. from and at 212 deg. per lb. combustible coal .....lbs.	12.64
18	Calorific value of 1 lb. of dry coal B. T. U.	10,765
19	Calorific value of 1 lb. combustible coal .....B.T.U.	15,500
21	Efficiency based on combustible .....79.13% (based on coal as fired).....	80.2%
21	Efficiency based on combustible 79.13%	
22	Cost of coal per ton (2000 lbs.) delivered at boiler .....$	8.75
23	Cost of coal for evaporating 1000 lbs. of water, F. and A. 212 deg.....	49.16c

HOURLY QUANTITIES

Time—8 a.m. to 9 p.m.	
Wt. of coal as fired .....lbs.	2,000
Wt. of water fed to boiler .....lbs.	14,000
Average Steam Pressure Gauge .....lbs.	150
Average Feed Temp. .....F.	60
Average Super Heat	0
Average Draft Over Fire .....inches	3
Average Flue Gas Temp. .....F.	550
Average Co2 per cent. .....p.c.	10
Per cent. Moisture In Steam	3

The test should be conducted for at least eight hours (the longer the better), and the hourly readings averaged up. The temperatures and pressures should be read frequently so as to obtain fair averages, and every few tubs or barrows of coal there should be a small amount of coal thrown into a box so as to get a fair average sample. The same is true of the ash and cleanings.

The main thing to remember is that we want to evaporate as much water as we can per lb. of coal fired. Note the style of firing, the frequency of coaling, and slicing, clinkering, cleaning, etc., for future reference.

The engineer who is conducting the test should have no part in the work except supervision. He should be free to go around from point to point making observations and above all have dependable persons as water tenders, at the measuring barrels. At the conclusion of the test the coal set aside for the sample is spread out on a clean part of the floor and broken up until it is quite small, not necessarily powdered, then it is quartered, that is divided in four sectors, throwing two sectors out each time until there is about a peck left. Box this up in a box sufficiently large that the coal when spread in the bottom will not be more than 2 in. deep, and place on top of boiler in a pretty warm place where some of the moisture will be dried out. (If the sample is quite dry, this will not be necessary, but frequently the coal is out in the weather and may be wet.) Before placing the sample away for drying weigh it and when taken down weigh it again. For instance if the sample put away weighed 20 lbs. and next day weighed 19 lbs.

$$\text{there would have been } \frac{(20 - 19) \times 100}{20} =$$

5 per cent. dried out. But this is not all the moisture. When the sample goes to the chemist he will find from 1 1-2 to 3 per cent. of moisture and this must be added to what has been dried out.

When we send the sample out for analysis before closing the box we will put a card inside giving the particulars we wish the chemist to analyze for. The following information is usually sufficient.

Required approx. analysis of enclosed sample of coal from plant of J. Jones & Company.

Shipment No.
Car Number.
Evaporation Test No.
Date of Evap. Test
Moisture.
Volatile matter.
Fixed carbon.
Ash
Sulphur, etc.

Treat the ash sample the same way except that the particulars required of the chemist are, the per cent. of combustible in the sample, giving the date of test, number of test, etc., so that we won't have the analysis sheet mixed up with some future test.

In the meantime while waiting for the results of the analysis, we may work up some of the test data to get a general idea of what the results were.

It is not always convenient to send out a sample for an analysis, and not always "absolutely necessary" since the purchasing dept. should have an analysis from the coal company supplying the coal, and this analysis should be available but its value is always more or less open to question.

We will now assume that the analysis has been made, and proceed to work up the test.

Let us say that the analysis of the coal sample is as follows:

Approx. Analysis

Moisture 2% + (5%) = (7% in coal as fire).
Volatile matter = 21.65%.
Fixed carbon = 47.80%.
Sulphur = 6.40%.
Ash = 18.00%.

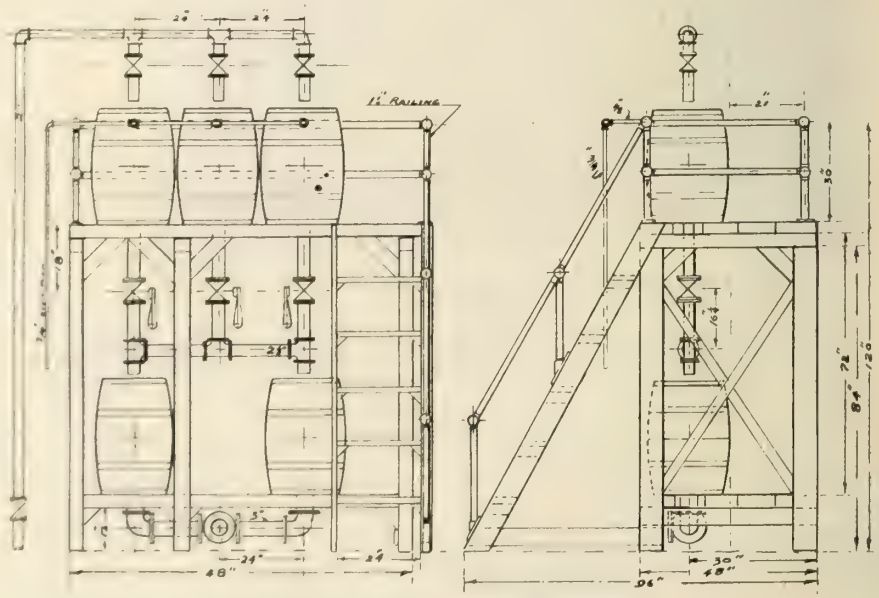
If we dried out 5 per cent. of moisture before sending the sample out we must add this to the 2 per cent. in the analysis report. Now the next thing to do is to find the heat value of the coal. Proceed thus. Find the percentage of combustible. The combustible is the volatile matter plus the fixed carbon. The sulphur is a combustible part, but in practice its heat value is so offset by other considerations that it is entirely ignored as a rule (a thorough explanation will take up too much space here) so we find by reference to the analysis report that the combustible is (21.65 + 47.8) = 69.45 per cent., by reference to the chart Fig. 4 and following the instructions we find that the heat value is 15,500 B.T.U. per lb. of combustible, and since a pound of the coal as fired contains only 69.45% of combustible

$$\text{the heat value is } \frac{(15500 \times 69.45)}{100} = 10765$$

B.T.U. per lb. as fired.

Let us now prepare a form in accordance with the A.S.M.E. Code.

Items 1 to 9 require no explanation, beginning with item 10. Dry coal per



Figs. 1 and 2.—Water measuring arrangement.

Data and Results of Evaporation Test

1. Test of ..... boiler located at .....
2. Number and kind of boilers .....
3. Kind of furnace .....
4. Grate surface (width.....length.....) ..... sq. ft.
5. Water heating surface ..... sq. ft.
6. Superheating surface ..... sq. ft.
7. Total heating surface ..... sq. ft.
   e. Distance from center of grate to nearest heating surface ..... ft.

Date, Duration, etc.

8. Date .....
9. Duration ..... hrs.
10. Kind and size of coal .....

Average Pressures, Temperatures, etc.

11. Steam pressure by gage .....lbs per sq. in
12. Temperature of steam, if superheated .....degs.
13. Temperature of feed-water entering boiler .....degs.
14. Temperature of escaping gases leaving boiler .....degs.
15. Force of draft between damper and boiler .....ins.
    c. Draft in furnace .....ins.
    d. Draft or blast in ash-pit .....ins.
16. State of weather .....
    a. Temperature of external air .....degs.
    b. Temperature of air entering ash-pit .....degs.
    c. Relative humidity of air entering ash-pit .....degs.

Quality of Steam

17. Percentage of moisture in steam or degrees of superheating .....% or degs.
18. Factor of correction for quality of steam .....% or degs.

Total Quantities

19. Total weight of coal as fired ..... lbs.
20. Percentage of moisture in coal as fired ..... per cent.
21. Total weight of dry coal fired ..... lbs.

hour = weight of coal fired per hour less the moisture, in this case 7 per cent. then multiplying the weight (sample tally sheet) $\frac{2000 \times 73}{100} = 1860$ lbs. (Enter this).

$$\text{Item 11} = \frac{1860}{84} = 22.14 \text{ lbs.}$$

Item 12 = (Actual water fed x Factor of evaporation). Here we must calculate the factor of evaporation, but before going any further we will have an explanation of what the factor means, and why it is used. In order that there would be some basis to compare the performance of steam boilers under different conditions of operation a rule was adopted by the A.S.M.E. and other engineering associations in convention, that a boiler H.P. shall be the evaporation of 34 1-2 lbs. of water at a temperature of 212 deg. Fah., into steam at the same temperature (which is simply evaporating water into steam at the atmospheric pressure).

If at one plant the boilers are generating steam at say 100 lbs. gauge from cold feed water and at another plant they generate at 150 lbs. gauge from hot feed water, their relative performance cannot be compared by the amount of water each evaporates, since the boiler using hot feed water will evaporate more than the one using cold water, this stands to reason.

Again, if one generates steam from cold water to a pressure of 100 lbs., and the other generates from the same temperature to a pressure of 150 lbs., they cannot be compared by the amount of water each evaporates, since the steam pressure is different.

It requires almost exactly 970.4 B.T.U. to change a pound of water at 212 deg. into steam at the same temperature. This is known as the Latent heat of steam at atmospheric pressure. Some steam tables now in use give the Latent heat of steam at atmospheric pressure as 958.6 and 966 B.T.U., but the latest accepted figures are 970.4 (make a note of this).

The formula for finding the factor of evaporation is

$$F = \frac{(H - t) + 32}{970.4}$$

in which H = total heat units in a lb. of steam at the given pressure (above 32°).
in which t = the temp. of the feed water.
in which F = the factor of evaporation.

The reason (32) is added to the numerator is because the tabled quantities (H) and (q) are above 32 deg. Fah. (the freezing point of water), while the feed water temperature is read in deg. Fahr. above zero. If 32 was subtracted from the feed water temperature then the formula would be $F = \frac{(H - t)}{970.4}$. In some of the text books we will find the formula written thus:

$$F = \frac{(L + q - t) + 32}{970.4}$$

which is exactly the same thing, since the column H is the sum of (L + q). Therefore (L + q) = H and $F = \frac{(L + q - t) + 32}{970.4} = \frac{(H - t) + 32}{970.4}$

Note that one boiler horse power is the equivalent of $\frac{(970.4 \times 34\frac{1}{2})}{60} =$ 557.98 B.T.U. per minute, equal to $\frac{557.98 \times 778}{33000} = 13.16$ mechanical horse power, so that the boiler horse power has no reference to engine horse power.

Now proceeding with Item 12, Eq. Evap. = (14000 x F) =

$$\frac{14000\ [(H - t) + 32]}{970.4}$$

and from the steam table (H, corresponding to the pressure of steam (150 gauge) = 1195 and substituting we have eq. Evap. =

$$\frac{14000 \times [(1195 - 60) + 32]}{970.4} =$$

$$\frac{14000 \times 1167}{970.4} = 16{,}836 \text{ lbs. (less 3 per cent.)}$$

(This should have been taken care of when calculating the factor of evap. See "quality of steam," etc.) Evap. =

$$\text{Item 13} = \frac{\text{Item 12}}{\text{Item 2}} = \frac{16531}{5000} = 3.367 \text{ lbs.}$$

Item 14 = The commercial H. P. x 34½ = (500 x 34½) = 17,250 lbs.

$$\text{Item 15} = \frac{\text{Item 12} \times 100}{\text{Item 14}} = \frac{16331 \times 100}{17250} = 94.7\%$$

$$\text{Item 16} = \frac{\text{Item 12}}{\text{Item 10}} = \frac{16531}{1860} = 8.9 \text{ lbs.}$$

$$\text{Item 17} = \frac{\text{Item 12}}{\text{lbs. Combustible}} = \frac{16331}{\left(\frac{1860 \times 69\ .45}{100}\right)} =$$

$$\frac{16331}{1291.8} = 12.64 \text{ lbs.}$$

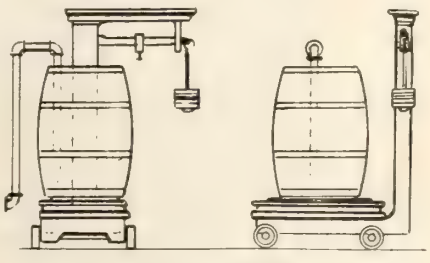


Fig. 3—Water measuring arrangement.

Item 18 = Value found by reference to chart = 10,765 B.T.U.

Item 19 = Ditto.

Item 20 =

$$\frac{\text{(Heat absorbed by the boiler x 100)}}{\text{Heat supplied in the coal}}$$

$$\frac{\text{(970.4 x Item 16 x 100)}}{\text{Item 18}} =$$

$$\frac{970.4 \times 8.9 \times 100}{10765} = 80.2\%$$

Item 21 =

$$\frac{970.4 \times \text{Item 17} \times 100}{\text{Item 19}} = \frac{970.4 \times 12.64}{15500} =$$

79.13 per cent.

Item 23 =

$$\frac{\text{(Item 22 x 1000)}}{\text{(Item 16 x 2000)}} = \frac{(8.75 \times 1000)}{(8.9 \times 2000)} = \frac{8.75}{17.8}$$

= .4916 dollars = 49.16c.

What the Test Shows

There is nothing to it, is there? "Well, not yet, anyway." The kink is to know whether the test is satisfactory or not, and if not just where the trouble is.

Let us assume that the efficiency of the boiler furnace and grate were found after an evaporation test to be 50 per cent., while the developed rating was only 95 per cent. There is something wrong here. We will find that the boiler heating surfaces are dirty or maybe that the firing was careless, allowing excess air through holes in the fire, or through leaks in the setting and fronts, carrying away too much heat to the chimney. The temperature of the flue gas is some indication of excess air and also of dirty heating surfaces, but no an infallible one, since the flue gas may be cooled off by the admission of air around the uptake. Again the flue gas may be hotter than it should be, but instead of dirty heating surfaces might be due to broken baffles allowing short circulating to the hot gases. This is where our draft gauge tells us something worth while. The readings should be taken at the uptake and in the first and second pass, as well as over the fire.

The flue gas temperature will be low according as the heating surface of the boiler is efficient, and vice versa. When there is no economizer in the uptake or path of the hot gases, the flue gas temperature should not exceed 500 deg. Fah. to 600 deg. Fah., depending upon how hard the boiler is being forced. When there is a superheater in the boiler the flue gas temperature is lower than if there is none because the superheater absorbs some heat, an ideal flue gas temperature would be pretty close to the steam temperature, but this is not possible of attainment in practice.

An analysis of the flue gas temperature may also be misleading if there are air leaks around the last pass, since the flue gas analysis is mainly to determine the completeness of combustion by analysis of the products thereof, it is important to be reasonably certain that the gases that are being analyzed are not mixed with air that leaks into the gas path between the furnace and the last pass, or point where the sample is taken. The presence of leaks in the uptake have no further effect on combustion than to reduce the power of the chimney to draw. That is combustion might be all that could be desired yet an analysis might indicate a great deal of excess air, due to infiltration through the setting beyond the combustion space. On the other hand the analysis might indicate good furnace conditions, while the reverse might be the truth, due to insufficient draft, or furnace volume combined with leaks in the setting. However to the experienced man, or one who studies the subject a little, there is usually no difficulty in running down any troubles to their source.

In average every-day practice it is not usual to analyze for carbon monoxide (CO) but the greatest importance is attached to amount of carbon dioxide (CO_2) present in the flue gas. A thorough instruction in "Flue gas analysis" has no place here and it is sufficient to state that if the average CO_2 is 12 per cent., the furnace conditions are as good as general every-day practice will admit. When the CO_2 is below 8 per cent. there is something radically wrong and it is invariably caused by excess air through rat holes in the fire.

There is a falling off in efficiency at high ratings due to forcing the fires, in order to get high capacities. This falling off is principally due to the high velocity of the gases through the boiler, preventing heat absorption by the heating surfaces and a consequent loss of heat up the chimney.

The chart Fig. 6 showing the draft loss between the damper and the furnace may be taken as some guide to the condition of the baffles in a vertically baffled boiler. The loss in a breaching is 0.001 inches per foot with 0.05 inches loss for every right angle turn and about 0.4 inches through the boiler.

As an example, assume the chimney to be 175 ft. high and the breeching 40 ft. long, one right angle turn at the entry to chimney and one at boiler uptake. Estimating $\frac{4}{10}$ loss through the boiler, what draft should be expected over the fire when the flue gas temperature is 500 deg. Fah. and the outside temperature 60 deg. Fah.

Theoretical chimney draft $D =$

$$H\left(\frac{7.64}{T_a} - \frac{7.95}{T_c}\right)$$

in which D = Draft in inches of water.

in which H = Height in feet above grate.

in which T_a = Absolute temperature of the outside air.

in which T_c = Absolute temperature of the flue gas.

The draft at the stack—

$$D = 175\left(\frac{7.64}{(60 + 461)} = \frac{7.95}{(500 + 461)}\right)$$

$$= \left(\frac{7.64}{521} - \frac{7.95}{961}\right) \times 175 =$$

175 (0.014683) — (0.008272) = 1.12 inches of water.

The actual draft will be about 80 per cent. of this. Therefore the measurement at the stack should read $\frac{(1.12 \times 80)}{100}$ = 0.896 inches.

Loss through the breaching = (140 x 0.001) + (0.05 x 2) = (0.04 + 0.1) = 0.14 inches.

Draft over the fire should read 0.896 — (0.14 + 0.4) = 0.356 inches.

In actual practice the draft gauge would read a little lower since some

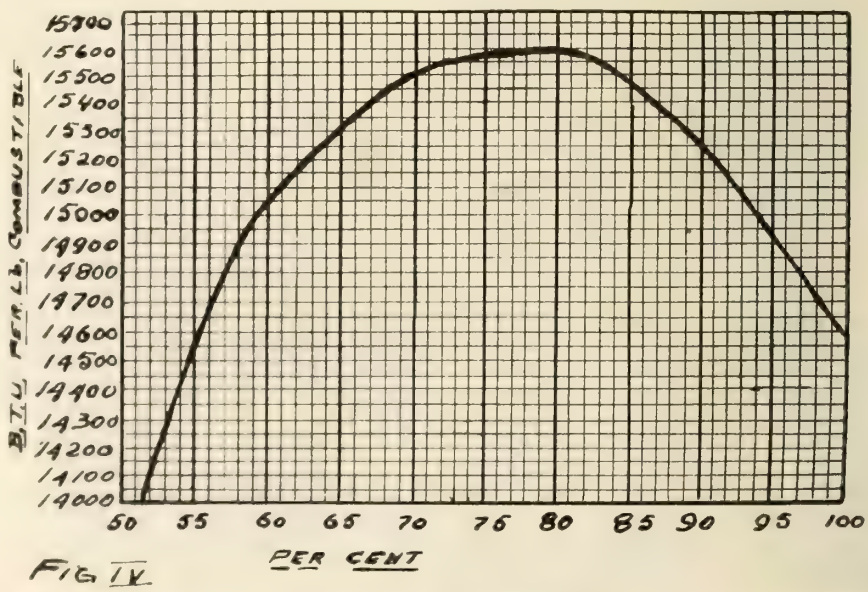


Fig. 4.—Chart for finding heat value per lb. of combustible. Correct to 3 per cent. when combustible in fuel is between 64 and 72 per cent.

slight allowances must be made, but should not read less than 0.3 or $\frac{3}{10}$ in. and certainly not more than $\frac{35}{100}$ when the fire is clean and burning free. A stronger draft over the fire would indicate short circuiting across the baffles (unless the fire is clinkered over) or would indicate very high flue gas temperature.

Quality of Steam

The quality of the steam is an important factor in a test report since it may be that a considerable amount of the water fed to the boiler may be carried away in the form of moisture in the steam, and credited to the boiler as being evaporated. There are three methods of finding the moisture content of a sample of steam. The one most common is by throttling calorimeter determination described in Fig. 8 which will give accurate results when the moisture content in the steam is not over four per cent. The separating calorimeter is probably the most reliable and will give accurate results even when there is considerable moisture present in the steam. The barrel calorimeter is sometimes used but it is not at all a reliable means and only the first will be described. When the amount of moisture in the steam is known, the quality of the steam is expressed as a percentage of its dryness. Example, a test shows 3 per cent. of moisture present, then quality of the steam is 93 per cent. and from this the factor of evaporation becomes

$$F = \frac{(xL + q - t) + 32}{970.4}$$

in which x = the quality of the steam expressed as a decimal.
in which F = Factor of evaporation.
in which L = Latent heat at observed pressure
in which q= heat of the liquid.
in which t = Feed water temperature.

Example—Quality of the steam is 93 per cent. = (0.93) observed pressure of the steam 150 lbs. gauge, feed temp. = 60 deg. F. Find the factor of evaporation.

Referring to the table of properties of saturated steam we find

$$L = 856.4 \qquad q = 337.7$$

$$\text{Then } F = \frac{(xL + q - t) + 32}{970.4} =$$

$$\frac{(0.93 \times 856.4) + 337.7 - 60) + 32}{970.4} =$$

$$\frac{1106.152}{970.4} = 1.14$$

When the steam is superheated it is usual to refer to an especially prepared chart if the greatest precision is required. But since the chart is prepared on the basis of the amount of heat absorbed by the steam per lb. the following formula will be sufficiently accurate for average purposes.

$$F = \frac{(H - t) + 32}{(S)} \text{ in which } S = 9704 + \frac{}{(2)}$$

the number of deg. of superheat.

That is it requires approximately ½ a B.T.U. to raise the temperature of 1 lb. of steam one deg. Fah. The specific heat of the steam varies with the pressure and averages 0.5 for moderate pressures. If it is desired to know definitely the exact factor for superheated steam it can be found as follows:

$$F = \frac{(XL + q - t) + 32}{(970.4 + Sc)} \text{ in}$$

which C = specific heat of steam at the observed pressure.

Now a final word on a subject that has caused more arguments than any other in connection with evaporation tests.

If the injector is used to feed the boiler and the feed temperature is measured at the entry to the boiler the steam used by the injector will not have to be estimated. If on the other hand the feed temperature is taken as that at the injector barrel the steam used by the injector must be charged against the evaporation.

The steam used by the injector is condensed by the water and all the heat is returned to the boiler except the small amount of radiation from the pipe and injector itself. Don't forget that the water the injector slops over at the overflow is measured water and must be accounted for. If it is at all possible the temperature of the feed entering the boiler should be known. The main thing to know on a test of this kind is the evaporation, unless the test is an overall one, it does not matter where the steam goes, whether to the engine, injector or pump. We are mainly concerned with evaporation (F and A) 212 deg.

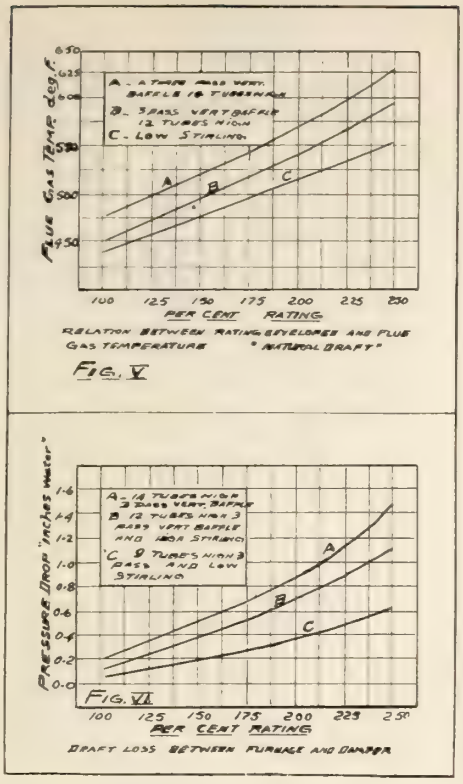

A - 4 PASS VERT. BAFFLES 16 TUBES HIGH
B - 3 PASS VERT BAFFLE 12 TUBES HIGH
C - LOW STIRLING
FLUE GAS TEMP deg F.
PER CENT RATING
RELATION BETWEEN RATING, ENVELOPES AND FLUE GAS TEMPERATURE "NATURAL DRAFT"
FIG. V
A - 14 TUBES HIGH 3 PASS VERT BAFFLE
B 12 TUBES HIGH 3 PASS VERT BAFFLE AND HOR STIRLING
C 9 TUBES HIGH 3 PASS AND LOW STIRLING
PRESSURE DROP INCHES WATER
FIG. VI
PER CENT RATING
DRAFT LOSS BETWEEN FURNACE AND DAMPER

Fig. 5.—Relation between developed rating and flue gas temperature.
Fig. 6.—Draft loss through boiler setting.

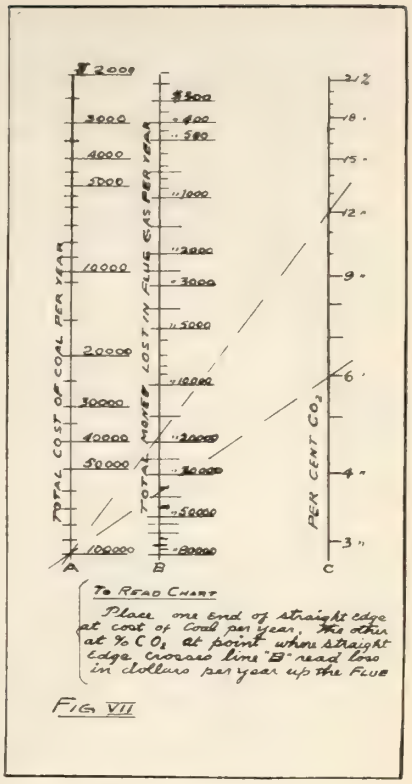

TOTAL COST OF COAL PER YEAR
TOTAL MONEY LOST IN FLUE GAS PER YEAR
PER CENT CO2
A
B
C
To Read Chart
Place one end of straight edge at cost of coal per year, the other at % CO2 at point where straight edge crosses line 'B' read loss in dollars per year up the Flue
FIG. VII

Fig. 7.—Chart showing saving by increase of CO_2.

First Method

Assume a pressure of 150 lbs. gauge and let the temperature of the water at the suction be 60 deg. Fah., and at the discharge 170 deg. Fah. Let the amount of water fed be 14,000 lbs. per hour, the heat units given up to the water are:

W (T — t) in which T = discharge temperature.

In which t = the suction temperature.

In which W = weight of water fed per hour.

Then Q = lbs. steam supplied to the injector.

L = Latent heat of steam at observed pressure.

$$14{,}000\ (T - t) = 14{,}000\ (170 - 60) = 1{,}540{,}000 \text{ B.T.U.}$$

Now all the heat units in the steam supplied at the observed pressure (150

Amount of Steam Used by the Injector

If the temperature of the water leaving the injector is known and the temperature at the suction is known, there are two simple methods by which we can find out the quantity of steam used, assuming it to be dry saturated steam.

lbs. gauge) above the temperature of the discharge (170 deg.) are represented by 1,540,000 B.T.U. and let us call the steam temperature at the given pressure of 150 lbs. gauge (Z). The lbs. of steam supplied to the injector can now be found.

$$\therefore Q = \frac{W\ (T - t)}{L + (Z - T)} = \frac{14{,}000\ (170 - 60)}{856 + (366 - 170)}$$

$$= \frac{14{,}000 \times 110}{1052} = 1{,}464 \text{ lbs. per hour.}$$

This can be proven by the formula used to find the final temperature of a mixture of steam and water.

$$\text{Thus } T = \frac{Q\ (L + Z) + (Wt)}{Q + W}$$

In which T = the final temperature of the mixture.
In which t = the temperature of the water.
In which Z = the temperature of the steam.
In which L = the Latent heat of the steam.
In which Q = the weight of the steam (lbs.)
In which W = the weight of the water (lbs.)

Substituting—

$$T = \frac{1464\ (856 + 366) + (14{,}000 \times 60)}{14{,}000 + 1464}$$

$$= \frac{(1464 \times 1222) + 840000}{14000 + 1464} = \frac{2629000}{15464}$$

= 170 deg. F.

The other method is by a slightly more difficult formula as follows:

$$Q = \frac{W\ [(T - t)\ D + 0.1851P]}{[H - (T - 32)]\ D - .1851P}$$

In which P = the absolute pressure of the steam.
In which D = the density of the water at the disch. temp. (or the wt. of water per cu. ft. at the dischg. temp.).
In which H = the total heat of the steam above 32 deg.

The other symbols as above.

Example—Assuming the same conditions as before (and taking the density of the feed water at 170 deg. = 60 lbs. per cu. ft.). Then

$$Q = \frac{14000\ [(170 - 60) + 0.1851 \times 165]}{[1199 - (170\text{-}32)]\ 62 - 0.1851 \times 165}$$

$$Q = \frac{14000\ (6600 + 30.5415)}{(1194 - 138)\ 60 - 30.5415}$$

$$\frac{14000 \times 6630.5415}{(1056 \times 60) - 30.5415}$$

$$Q = \frac{92827000}{63329.5} = 1462.5 \text{ lbs. per hour,}$$

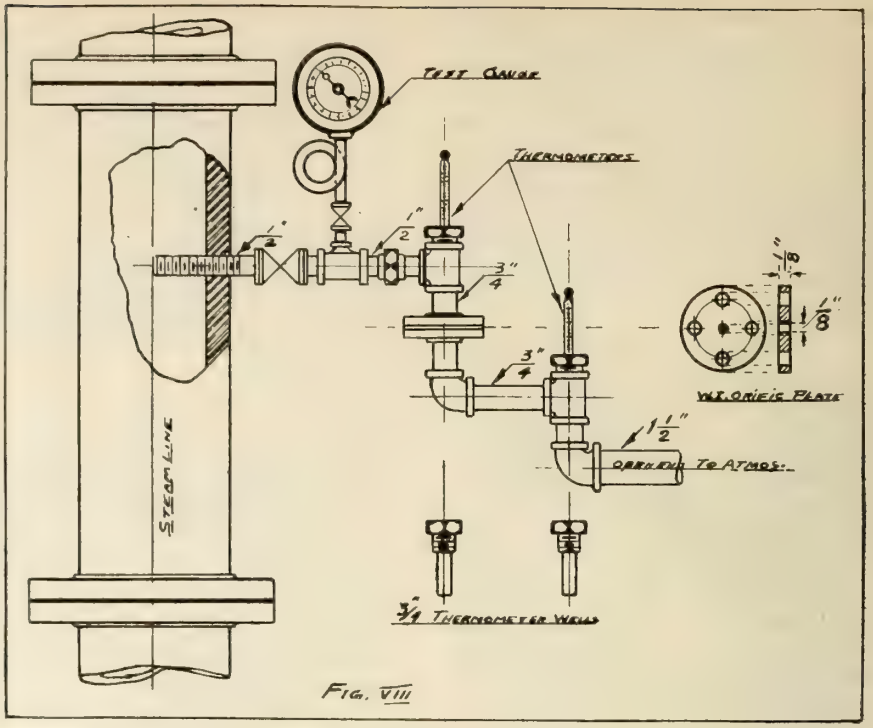


Fig. 8.—Throttling Calorimeter.

or a difference of 1½ lbs. for the last method which is the correct one, but much more cumbersome.

Fig. 8 illustrates a throttling calorimeter that can be made by anyone. The only point is that two excellent authorities disagree about two of the features.

One authority advises that the ½ in. pipe inserted in the steam line should be perforated with 1-8 in. holes and that they should not be within ½ in. of the walls of the steam line and that the orifice in the plate should be 1-16 in.

While the other advises that there should be no perforations and states that the orifice should be 1-8 in. diameter and the end of the tube midway in the stream.

The upper thermometer is used to check the steam pressure gauge, there should be perfect agreement between them. The lower thermometer reading is used to find the quality (x) of the steam.

To estimate the quality of the steam we have the following formula:

$$x = \frac{(H - q) + 0.46\ (T - t)}{L} \text{ in which}$$

x = quality of steam expressed as a decimal.
H = Total heat of dry steam (saturated) at atmospheric pressure — (1150.4).
q = Heat of the liquid corresponding with the boiler pressure (B.T.U. per lb.).
T = The temperature shown by the lower thermometer.
t = The temperature of saturated steam at atmospheric pressure = (212 deg. F. when the atmospheric pressure is 14.7).
L = the latent heat of steam at the boiler pressure 0.46 = the specific heat of superheated steam at atmospheric pressure.

Example—Assume that the boiler pressure is 150 lbs. gauge and the upper thermometer reads 366 deg. F. the lower 250 deg. Estimate the quality of the steam

$$x = \frac{(H - q) + 0.46\ (T - t)}{L} =$$

$$\frac{(1150.4 - 338.2 + 0.46(250 - 212)}{8.56.8}$$

$$= \frac{812.2 + 2208}{856{,}8} = \frac{834.28}{856.8} = 0.9737 \text{ or}$$

97.37 per cent. dry steam, or in other words the test shows that the steam contains 2.63 per cent. moisture.

A few remarks about the value of an evaporation test to determine the advantage of using one grade of coal as compared with another, then I will leave the reader by himself to go to it and test to his heart's content. I know that he won't for the consideration of two or three old oil casks and a few fittings be content to set back and let dollars and dollars flow out the chimney, and to further interest him I will give him an actual instance which came to the writer's notice, the thing was actually done by very common fellows, under the direction of an excellent engineer, who is a Canadian and a graduate of a Canadian college.

But the thing was so simple when demonstrated that it was amazing even to some of us who thought we knew a lot.

A certain plant was evaporating an average of 5,000,000 lbs. of water per week. The cost of evaporation was found to be 52 cents per thousand lbs. (coal

prices were sky high at the time, and are yet for that matter).

$$\text{Cost of evap. per week} \frac{(5000000)}{1000} \times \frac{52}{100}$$

= $2600 per week.

By a series of evaporation tests and making use of the information thus gained to bring up the efficiency of operation, and demonstrating the proper kind of fuel to use, and how to use it, the cost of evaporation was reduced to 26 cents per thousand lbs., a saving of $1300 per week. (The cost referred to is evaporation cost not production cost) at the expense of a little extra time and equipment picked up on the plant. This is not a fairy tale but an actual fact. Well, was it worth while? I'll say it was.

Fuel is or should be purchased on a heat unit basis. That is on a basis of B.T.U. per dollar but it does not follow that the highest grade coal is the most profitable in all cases, and the only way to demonstrate is by an evaporation test under actual working conditions.

Boiler furnace and grate efficiency is one thing, cost of evaporation is another, and capacity is still another. So by a series of evaporation tests, carefully conducted, with the most meagre equipment we will find out that a great deal of what we had taken for granted is not so, and when we have closed up the open "bung hole" in the boiler room, we will proceed to the engine room to see whether there is a leak at the spigot.

Application of the Chart Fig. Four

To estimate the heat value of a coal with a given approximate analysis, add together the percentage of fixed carbon and the percentage of volatile matter in the coal, divide this sum into the percentage of fixed carbon and multiply by 100. This gives the percentage of fixed carbon in the combustible or

$$\frac{\text{(Fix. Car.) } 100}{\text{Fix Car + Vol.}}$$

= percentage of fixed carbon in combustible.

Locate this percentage at the foot of the chart, extend your pencil straight up until you strike the curve, then following the nearest horizontal line read the B.T.U. per lb. of combustible. Multiply the value thus found by the percentage of combustible in coal and the result will be the heat value of the coal per lb.

Example—If the volatile matter is 30 per cent., and fixed carbon is 45 per cent.; find the heat value.

$$\text{Then } \frac{45 \times 100}{45 + 20} = \frac{4500}{65} = 69.23$$ locating this point on the curve and following the horizontal line to the left we find the heat value per lb. of combustible = 15,500 B.T.U. and since the coal contains (45 + 20) = 65 per cent. combustible. The heat value is $\frac{15500 \times 65}{100}$

= 10,075 B.T.U. per lb.

VAPOR ACCUMULATORS

In the majority of industrial plants where steam i used, the steam consumption varies. This means that the fire under the boilers will have to be changed according to the variation in the steam consumption, which again means poor steam economy with the risk of either shortage of steam or a surplus, with the safety valve blowing.

Instead of giving their attention to the matter of obtaining the best possible combustion with a high CO-2 percentage, the firemen have to watch the pressure in the boilers, always to be ready to increase or decrease the steam flow.

If the firemen has fixed the load and the draft of the boilers for a good combustion, the next time he changes the rate, the CO-2 will drop or go too high, and thus it is impossible always to keep the combustion at the point where it should be.

It is also a common occurrence that one or two boilers are kept under fire in order to take care of the peaks in the load which can not be provided for from the boilers normally required

It is obvious that the economy of these "spare" boilers is exceedingly poor.

The above conditions which undoubtedly have been noticed by every boiler house superintendent, have been considered impossible to get away from, and, on account of the absence of any way to improve them, they have been considered unavoidable.

Lately, however, an invention called the "Vapor Accumulator" has come into use extensively in Europe and the results obtained with same have been very good.

The idea of the "Vapor Accumulator" is, to store the excess steam produced at times of low steam consumption, until periods of high steam demand, when it is again drawn off.

The accumulator, in other words, acts as a buffer between the steam producer and the steam consumer and the firemen have only to watch that the accumulator does not get empty or too full.

In this way, the boilers need only produce the average quantity required for the plant and the load of the boilers can be kept even and independent of the temporary steam requirements.

It is evident that only that number of boilers necessary for the production of the average steam quantity required need to be under fire, which means that the "spare" boilers can be entirely eliminated and often one or two more of the others.

The accumulator is equipped with complete automatic regulation worked by the pressure in the various steam lines. This gives a practically constant pressure to all steam consumers.

Beside the direct saving of fuel gained by the use of the accumulator the operation of the plant itself is simplified to a considerable extent.

The power house takes the place of an auxiliary equipment in the plant, which it ought to have, after the "Vapor Accumulator" has been installed, and not, as has heretofore very often been the case, the position of the most vital part of the plant, according to the condition of which every other department had to be operated.

In case of a sudden stop in the operation of a boiler, or cleaning, etc., the accumulator will step in, to a certain extent, so that no break in the steam supply will be noticed in the other departments of the plant.

In pulp and paper mills where it is of utmost importance to have an even and high quality of the product, it is very valuable to be able to keep the desired pressure constant both in the digester houses, paper machines, drying machines, etc., at all times, even when, for one reason or other, there should be disturbances in the boiler house.

NEW MINE RESCUE APPARATUS

Ever since the invention of the Miner's Safety Lamp by Humphry Davy, Great Britain has devoted keen attention to the subject of safety devices in mines. Experiments recently conducted by the British Scientific and Industrial Research Department have resulted in the design of two new types of rescue apparatus which are proving most successful. Both types of apparatus are what is known as "regenerative"; that is to say, the air expelled by the lungs is purified, supplied with oxygen, and returned to the lungs. Therefore, when a man wears this apparatus he is able to enter smoke or poisonous atmosphere without suffering ill effects. The apparatus and the lungs really form a closed circuit, and the lungs serve as a pump to circulate the air round that circuit. In one type of apparatus the oxygen is supplied from liquid air and in the other type it is obtained from a solution of compressed gas. Both pieces of apparatus are designed to enable the wearer to undertake continuous heavy physical exertion for at least two hours. As a matter of experience they can satisfy all the breathing needs of the wearer for three hours.

The largest Hydro Electric Plant at Chippawa was officially opened on Wednesday, December 28th. About 2,000 municipal representatives were present, and water was released into the first installed turbine setting in motion the 55,000 H. P. generator. At the present time only one turbine will be used but when the actual plant is completed there will be nine turbines in all which will have approximately a capacity of 650,000 H. P.

The Gas and Oil Engine In the Power Plant

The Internal Combustion Engine Is Becoming of More Importance to The Power Plant Field Daily. This Article, The First of a Series, Discusses The Leading Principles In a Plain Manner

By T. H. FENNER.

THE power plant engineer in Canada has been inclined to look on the internal combustion engine in its various forms as something which possessed but little interest for him. What attention he had given to this form of prime mover has been rather superficial as being something out of his immediate needs. The time has come however, when that attitude must be changed, for the internal combustion engine is now in active operation in a large number of places in Canada. The man who has confined his attention to steam entirely, may suddenly be called upon to attend to an engine which uses a different medium to produce its power, and every man should have at least a good general knowledge of the principles under which these motors work.

Internal Combustion

When we speak of the internal combustion engine, we mean any engine in which the working medium, or fuel, accomplishes the chemical combination with oxygen which we know as combustion, in the same chamber in which the power made available by combustion is used. That is the fuel is mixed with air necessary for its complete combustion, ignited, and develops its power while in direct contact with the piston which it is to drive.

In the steam engine on the other hand, the fuel is ignited and combustion completed, in a vessel absolutely distinct and apart from the engine which is to be utilised to develop the power of the fuel. The heat of combustion is transferred to the water in the boiler by radiation and conduction from the furnace and combustion chambers, and the result is the change of water into a gas, which carries part of the heat of combustion over to the engine cylinder, and there gives it up by doing work on the piston. The above short description shows the fundamental difference between the two types of engine, and it will need only very slight consideration to show wherein lies the superiority of the internal combustion engine from the point of view of heat efficiency.

Heat and Work

Any engine at all is a heat engine, and is merely the mechanism by which the foot pounds of work contained in the heat supplied may be converted into mechanical energy. Whatever the fuel we may use to give us this heat supply, it will contain a certain amount of energy in the form of heat units, it is the object of the engineer to transform these heat units into mechanical energy with the least possible loss taking place in the

One pound of ordinary coal contains about 11,000 B.T.U. and this expressed in foot pounds is 8,558,000. If the energy contained in the pound of coal could be developed over the period of one hour without any loss, then measuring in our usual terms for power, we should have 142,633 ft. lbs. per minute, or power at the rate of 4.3 horse power for one hour. That is, the energy contained in one pound of coal is sufficient if it could be applied without loss to develop 4.3 horse power hours.

Now what do we find in practice? The most efficient prime mover using steam as a working fluid develops one horse power hour for the consumption of one pound of coal. That is the pound of coal actually develops in the best apparatus that we have only a little less than one quarter the energy equivalent of the heat units it contains. Evidently here we are a very long way from our object of transforming the potential energy of the fuel into the mechanical energy we require without loss. With steam as the working medium, that is the medium which transmits the heat from the boiler to the piston of the engine and there allows it to do work, the above result is about as good as can be obtained. The use of oil as fuel instead of coal shows some improvement over this but still losses are enormous and to the steam engineer are only too familiar. A brief mention of them here will suffice. There is the loss caused by unburnt fuel dropping in the ashpit, the loss caused by the waste heat carried up the stack, losses by radiation from the boiler, steam pipes, etc., loss caused by condensation in the cylinder if the engine is a reciprocating one and the loss in the exhaust.

It is quite obvious that if we have a means of developing the heat units right where they are to perform their work, and have the heat energy developed directly in the working fluid, that we shall have eliminated a large amount of the sources of loss. This then is where the internal combustion engine obtains its great advantage.

In the Diesel oil engine one horse power is developed on a consumption per hour of about one half pound of fuel. If the fuel supplied to the engine contains 18,000 B.T.U. per lb., then we have 9,000 B. T. U. per hour. That is enough energy without loss to supply work at the rate of 3.5 h.p. or 3.5 horse power hours. Comparing this with our highly efficient turbine unit we find that in the oil engine we have obtained .2857 of the work actually available in the fuel, while in the steam turbine we have only obtained .2325. We have gained nearly 22 per cent. in the oil engine as compared with the fuel used in the steam turbine.

We have made this gain because the heat energy contained in the fuel has been applied to the machine which transforms it into mechanical energy in a much more direct manner. The unavoidable losses in the internal combustion engine are confined to the heat carried away in the circulating water, and the heat in the exhaust gases. The heat carried away in the circulating water would if not taken care of, result in the walls of the cylinder and the piston becoming red hot with disastrous results. The heat contained in the exhaust gases can be utilised if necessary in much the same manner that the exhaust steam from an engine can be utilised for heating purposes.

We have explained in a brief way where the internal combustion engine derives its great advantage over the steam engine, and while there will be no attempt in these articles to go into the thermo dynamics of the question, there is a simple means of showing in figures the great advantage of the internal combustion engine from a thermal point of view.

Heat Efficiency

In discussing questions relating to heat engines, it is usual to calculate from the absolute zero of temperature, instead of the ordinary thermometric reading. Many of our readers will be familiar with this method but for those who are not, it will be just as well to give a short explanation of what we mean by the absolute zero of temperature.

Absolute Zero

In investigating the effect of increases of temperature on the volume of air, it was found that every degree of temperature added on the Fahrenheit scale gave an additional volume of 1-460 part of the original. It necessarily followed that for every decrease of one degree a corresponding diminution of volume would occur, and if this was followed to its logical conclusion, there would be a point reached where there would be no volume, and accordingly no temperature. This point would occur at a temperature of 460 below zero Fahrenheit, and though such a temperature could not actually be attained, it formed a convenient base for a starting point. Therefore 460 below zero Fahrenheit is said to be the absolute zero of temperature Fahrenheit, the corresponding zero on the centigrade scale being 273 below zero.

The efficiency of a heat engine depends on the range of temperature of the working fluid in the cylinder, that is the greater the distance between the

initial and final temperatures, the greater the efficiency. This ideal theoretical efficiency is therefore expressed as follows:

$$\frac{\text{Heat put in—Heat rejected}}{\text{Heat put in}} \times 100$$

equals the efficiency expressed as a percentage. This is again expressed by the formula

$$\frac{T - t}{T} \times 100$$

where T is the absolute initial temperature and t the absolute final temperature.

This formula expresses the ideal efficiency, because in practice there are losses of heat from the radiation, etc., from the cylinder, which are not available for doing work. It forms however a convenient basis for showing the difference in efficiency between an engine using steam as a working medium, and one using a fuel which is burnt directly in the cylinder.

Thus if we take the example of our turbine, with an initial steam pressure of 150 lbs. per square inch, exhausting at 2 lbs. absolute we have the following values for the formula:

$$\frac{358.5 + 460 - 126.15 + 460}{818.5} \times 100$$

which is 28.1 per cent.

Now take an oil engine working between the temperatures of say 1,700 and 850, which would be 2,160 absolute and 1,310 absolute. By the formula

$$\frac{2160 - 1310}{2160} \times 100$$

is equal to 39 per cent.

Thus we see that the temperature range possible in an oil engine is far greater than that in a steam engine, and further the losses are far less if we consider the losses from furnace to exhaust in the steam engine.

The foregoing shows that the internal combustion engine considered as a heat engine is considerably in advance of the steam engine, but it must not be supposed that for every purpose the internal combustion engine can supplant the steam engine. The choice between the two prime movers would be influenced in many cases by local conditions, such as price and availability of coal, or oil, nature of the work to be done, investment costs, etc. Thus in a factory where large amounts of steam had to be used for process work, and for factory heating in the winter, a steam plant would very likely be the better proposition. On the other hand, in many localities where coal is both poor in quality and dear in price, and the power is required for generating electricity, the internal combustion engine could show many advantages.

A special field for the internal combustion engine has developed in the case of municipal water works where the water is pumped by means of centrifugal pumps direct connected to motors operated by electric power. There is a necessity in these cases for a standby unit, which can be always ready to start in case of failure of the electric power. Formerly it was the practice to put in a steam plant for this purpose, and naturally the charges involved were heavy due to the necessity of constant attention, and the cost of keeping fires banked, as well as a reserve of coal which had to be kept on hand.

The introduction of internal combustion engines to these plants gave a unit which was always ready to be put in commission at a moment's notice, which involved no standby costs, a very small investment in fuel, and no attention when not in use. We shall give some particulars of these installations in a future article.

Different Types of Engine

The term internal combustion engine covers a wide variety of motor, and they can be divided into types, according to the fuel used, and the cycle employed.

Thus there are the gas engines, which use as fuel, gas furnished by gas producers, town gas, or waste gases from blast furnaces, etc.

The engines using the lighter distillates such as coal oil, gasoline, benzine, etc., and adapted to the use of automobiles, areoplanes, etc., and small motors for concrete mixers, threshing machines and small lines of shafting.

There are the engines using the heavy oils, such as crude oil, and known as Diesel or semi-Diesel engines.

In the gas and gasoline engines, the charge is ignited by means of a spark produced from a battery or magneto. In the semi-Diesel engines ignition is produced by means of a portion of the cylinder cover which is uncooled, and thus attains a temperature which keeps it red hot, this heat serving to ignite the fuel charge when introduced. When starting the engine it is necessary to heat this portion of the cover, which is known as the hot-bulb, by some external means. There are various devices for this purpose. From the method of ignition this type of engine is often referred to as a hot-bulb engine.

The full Diesel engine differs from all the others in that the necessary heat for explosion of the charge is produced by the compression of the air in the cylinder, by the piston of the engine. This compression is high enough to produce a temperature in the cylinder of about 1000 degrees before the charge is admitted. The high temperature ensures instant ignition of the charge, and combustion is almost perfect. Owing to the high compression used, a very high range of temperature is secured, and these conditions make the Diesel engine the most efficient heat engine that we so far have developed.

(To be continued)

DON'T FORCE A BELT TO RUN ON THE PULLEYS

"Many millwrights make the mistake of thinking that it is perfectly proper to force a belt to stay on its pulley by any means whatever." "They seem to think, continues a writer in 'Belts,' "that as long as the belt 'runs' it is all right, and is doing as much as should be expected of it." For instance, one millwright "took a piece of old three-inch rubber belt, pulled off one ply, wrapped it twice around the centre of a wooden pulley and nailed it solidly to the pulley," and then he goes on and says, "The belt immediately took its place in the centre of the pulley and stayed there."

It is true that nailing a ridge of any kind of belting on a wooden pulley to increase the crown will cause the belt to move over and run on the intensified crown, even though the alignment of the pulleys may be poor. However, such a condition is hard on the belt, as a little thought would show that if the belt has much work to do it cannot endure.

Let us say that the width of the belt is 6 inches, and that the width of the ridge nailed on the pulley is only 3 inches. 6 inches minus 3 inches equals 3 inches, which means that about 3 inches of the belt (1½ inches on each side of the centre) is not in contact with the driving pulley or driven pulley at all or is in poor contact. A very intense pressure between the belt and the pulley occurs over the 3 inches of width of the ridge. In other words, 3 inches of width of belt is compelled to do what 6 inches was intended to do.

Furthermore, with the rough face of the ridge rubbing against the equally rough face of the belt, and with the pull per square inch and the pressure per square inch doubled, it is evident that the wear on the 3-inch ridge is going to be greater than it would be on a smooth iron or smooth wooden pulley. It is quite possible that the slip is greater with the 3-inch strip than without the strip. At least the creep is as great one way as the other. From every angle, therefore, it is obvious that nailing a ridge around pulleys to increase the crown is poor engineering.

It is far better to carefully align the pulleys and shafting so that the belt will run exactly as was intended by the designers of the pulleys. By using the low crown, the entire belt surface comes in contact with the pulley, both the load and the wear are evenly distributed. In fact, pulley coverings should not be used at all. It has been proved time and again that the natural smooth face of a metal, wooden or other pulley is far superior to any roughened face. Rough faces are too hard on the belt.

Plumbing and heating contracts for additions to hospital costing $107,986 for the Royal Jubilee hospital, Victoria, B. C., have been awarded.

Burning Wood Refuse in Mechanical Stokers

The Successful Combustion of Wood and Other Factory Refuse Has Always Been an Interesting Question—This Article Describes Various Types of Boilers Fitted With Underfeed Stokers For This Purpose

By R. L. BEERS*

UNTIL RECENT years many plant engineers considered the burning of wood refuse more from the standpoint of an easy method of disposal rather than a source of fuel supply. The high cost of coal, however, and the difficulty of securing it has caused considerable inquiry as to the proper methods to be used in burning wood refuse of various sorts so that the utmost heat value could be obtained.

There are such wide differences in the heat and moisture content that special furnaces are necessary for each kind of refuse to be burned. Where the moisture content approximates 70 per cent., burning the refuse becomes simply a matter of disposal—as the heat content is all required to evaporate the moisture.

There are three general classes of wood refuse that have been burned extensively on underfeed stokers. These are hog-feed, tan bark and sawdust.

Burning "Hog Feed"

"Hog Feed" is the most important of these three and is available in a number of plants in large quantities. "Hog Feed" is refuse wood obtained from pulp, paper and sawmills and consists of chips, blocks, etc., that have been put through a hogging machine or macerator. These machines, with the action of revolving knives, cut or shred the wood into a condition in which it can readily be handled as fuel. Mill refuse fuel is available at most of the pulp and paper plants and in lumbering sections. It is quite an important fuel on the Pacific Coast where there is a surplus of the material and it is sold to plants for steam purposes. The fuel usually contains a high percentage of moisture, varying from 40 to 75 per cent and it is essential in burning it that a large combustion space be supplied. On account of the high moisture contained there should be much heated brick work to radiate the heat to the fuel bed and thus assist in evaporating the moisture. Dutch ovens or extension furnaces of the proper size are usually essential for good results.

A common practice in burning this fuel has been to use natural draft and ordinary grates. The best results, when burning on grates, have been obtained by using a Dutch oven or extension furnace and dropping the refuse through an opening in the top of oven. This has been the common practice. However, with natural draft, the efficiency in burning the fuel is not very high. It is necessary to keep feeding a large volume of the fuel which requires constant opening and closing of the feed hole in the top of the Dutch oven. The feed hole is often left open permanently. This admits to the furnace a large volume of excess air that cools off the gases and makes it difficult to generate the maximum possible amount of steam. Better results have been obtained by using forced draft under the grates. This permits carrying practically a balanced draft over the fire and there is not so much excess air drawn in through the feed hole.

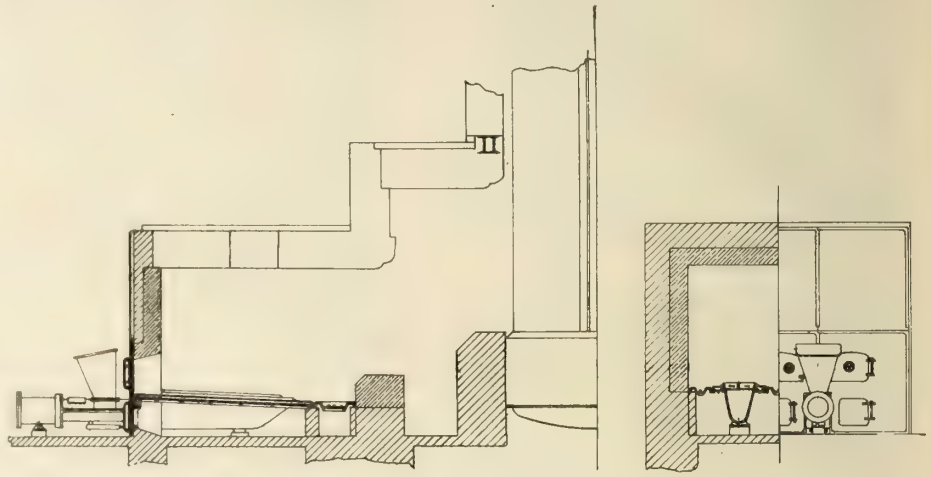


Fig. 2.—Wet wood furnace and stoker.

A standard type of under-feed stoker with stationary dead plates for hand cleaning has been extensively used for burning this fuel. The stoker offers a decided advantage over the forced draft grate fire as it is possible to have a fire both at the bottom of the pile of refuse as well as at the top of the pile. With the ordinary grate firing the fire is practically at the surface as the hot brick work radiates heat to the conical refuse pile, drying it out and igniting it. With the stoker a small amount of coal is fed through the retort which maintains a fire at the bottom of the fuel bed. This is essential in burning refuse with a high moisture content. The feed opening for the refuse is usually directly over the retort and the thin part

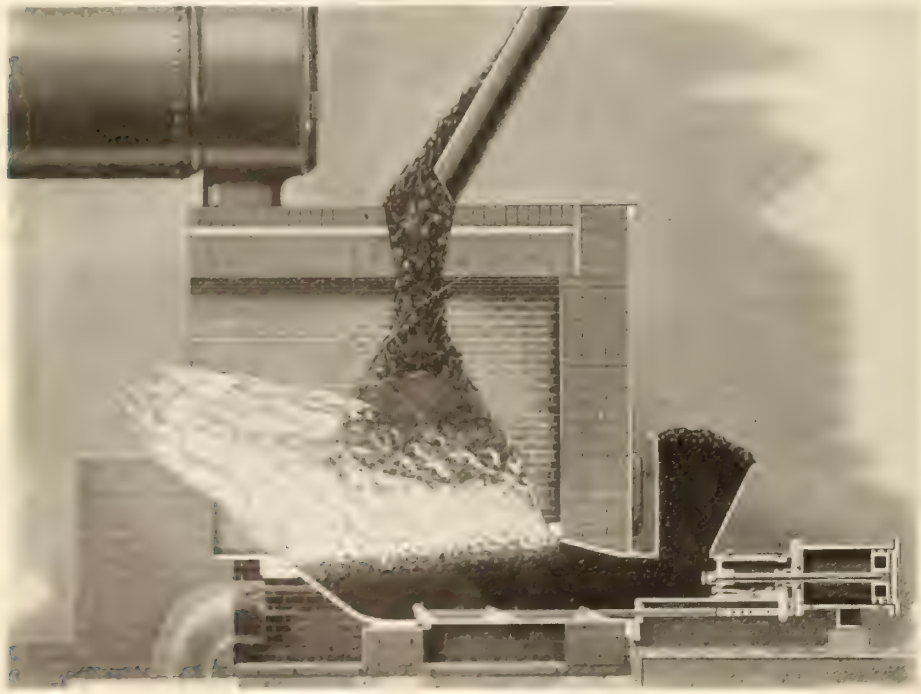


Fig. 1.—Hand-cleaned type stoker for burning hog fuel.

*By R. L. Beers, Assistant Chief Engineer, Underfeed Stoker Co. of America.

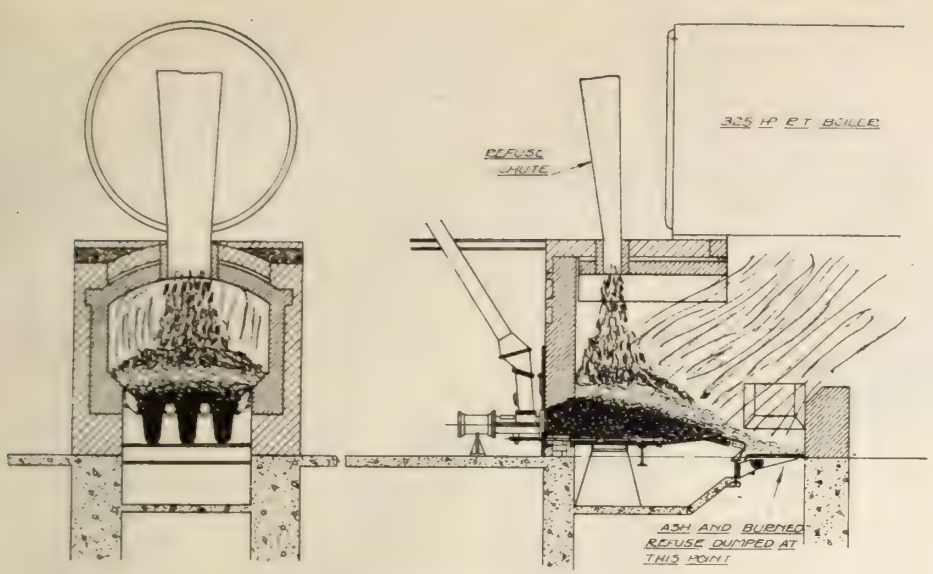


Fig. 3.—Stoker and furnace for H. R. T. boiler.

of the tapering holes over the dead plates. Thus the air must pass through the deep part of the fuel bed. With hand firing and forced draft usually the thin part of the pile is next to the wall and the air, naturally taking the path of least resistance, tends to blow holes through the thin part. With the stoker it is also possible to change quickly from hog feed and coal to straight coal in case there is a shortage of the refuse.

Burning Coal and "Hog Feed"

When burning coal and "Hog Feed" with moisture under 50 per cent. it is possible to obtain higher boiler ratings with the coal and refuse combined than when burning straight coal. At one plant, where the hand cleaning type of under-feed stoker was installed, to operate boilers with coal at 125 per cent. of rating the boilers have been operated up to 200 per cent. of rating continuously when burning coal and refuse. However, when burning straight coal, the boilers could be operated at only 150 per cent. of rating. In Fig. 1 is shown the hand cleaned type of under-feed stoker as applied to a horizontal return tubular boiler for burning "Hog-Feed."

In the majority of plants the bark from the barking machines is wasted and very often difficulty is experienced in disposing of it. In some localities laws have been passed to prevent dumping it into streams. It can be disposed of and a saving made by burning on stokers under boilers. It is being burned on the under-feed stoker with Dutch oven setting and return tubular boilers. At one plant the bark is carried out of the barking machines by a flowing stream of water from which it is finally separated and run through two sets of squeezers before being conveyed to the furnace. The bark is very wet, it being possible to squeeze water from it by hand. A sample taken showed 70 per cent. of moisture. It is of course, essential to burn a small amount of coal to get good results with this wet refuse. Fig. 2 shows the application of stoker to a vertical tubular boiler.

The standard hand cleaned type of stoker is particularly adaptable and has been extensively applied in burning refuse under the smaller size boilers of 100 to 300-h.p. However, for the larger size units, the automatic cleaning stoker is better adapted. It will not only burn large quantities of "Hog Feed" but it is possible to obtain high boiler ratings when burning straight coal.

Fig. 3 shows an installation of three long retort automatic-cleaning underfeed stokers, under 325-h.p. horizontal return tubular boilers. These furnaces have one feed hole for the refuse through the top of the extension furnace. Conveyors keep a continuous stream of refuse falling through this opening. At a test made at this installation the boilers were operated at 177 per cent of rating by burning 246-lb. of coal and 2550-lb. of "Hog Feed" per retort per hour. It would have been possible to have obtained even higher rating if there had been more stack draft. The refuse consisted of trimmings and edgings of spruce, tamarack and jack pine and sawdust.

Following are some of the results of a test on the above boilers when burning "Hog-Feed" and coal:

Boiler

Horizontal return tubular 90-in. dia.; 20-ft. long; rated at 325-hp.; 3413 sq. ft. heating surface.

Stokers—

Automatic cleaning, 3 long retorts.

Conditions

Steam pressure, lb. gauge	119.7
Temp. of feed water, deg. fahr.	229.0
Temp. of escaping gases, deg. fahr.	683.0
Pressure in air chamber, inches	1.6
Draft in furnace, inches	0.05
Draft between damper and boiler, in.	0.50
Carbon dioxide in flue gases, per cent.	14.8
Factor of Evaporation	1.002

Coal Analysis—

Fixed carbon, as fired, per cent.	48.96
Volatile matter, as fired, per cent	36.38
Ash, as fired, per cent.	10.65
Moisture, as fired, per cent.	4.01
Sulphur, as fired, per cent.	3.26
B. t. u., as fired, per cent.	12,362

"Hog Fuel" Refuse Analysis

Moisture, as fired, per cent.	41.65
Ash, as fired, per cent.	4.0
B. t. u. as fired, per cent.	4,220

Summary—

Coal burned per hour, lb.	245.5
Coal burned per hour, per retort, lb.	81.8
Refuse burned per hour, lb.	7,680
Refuse burned per hr., per retort, lb.	2,560
Water evaporated from and at 212 deg. per hour, lb.	19,914
Boiler hp. developed—average	577.2
Percent of rated capacity developed	177.6
Coal burned to develop one b. hp., lb.	0.43
Refuse burned to develop one b. hp., lb.	13.31
Pounds of refuse per cu. ft., lb.	16.67

Figs. 4 and 5 show stokers as applied to 500-h.p. water tube boilers.

Under the proper conditions when

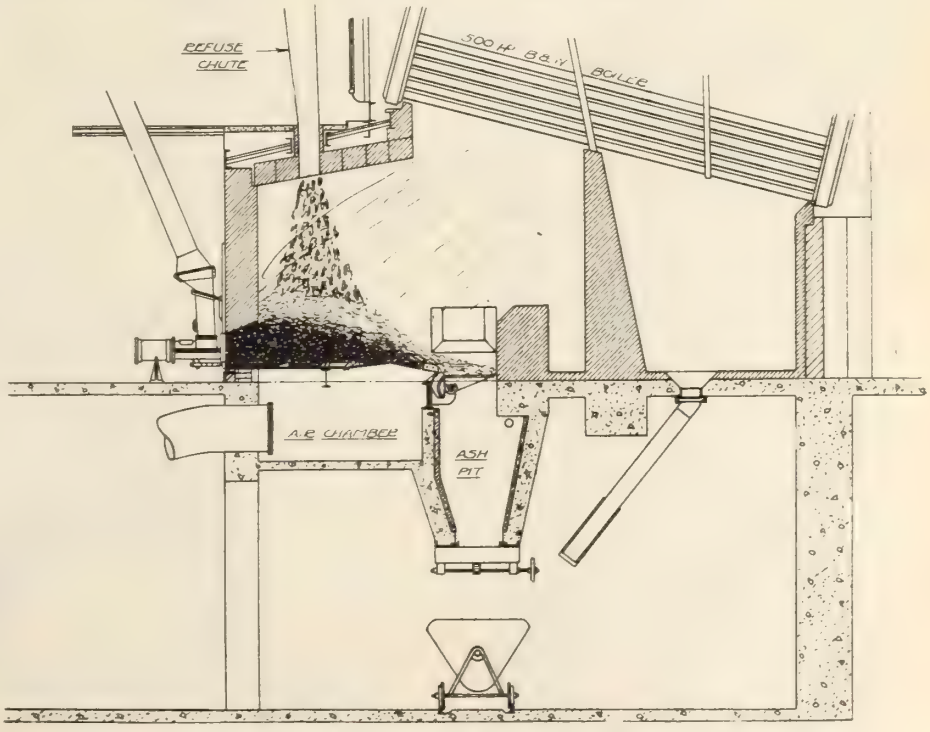


Fig. 4.—Horizontal water tube boiler equipped for hog fuel.

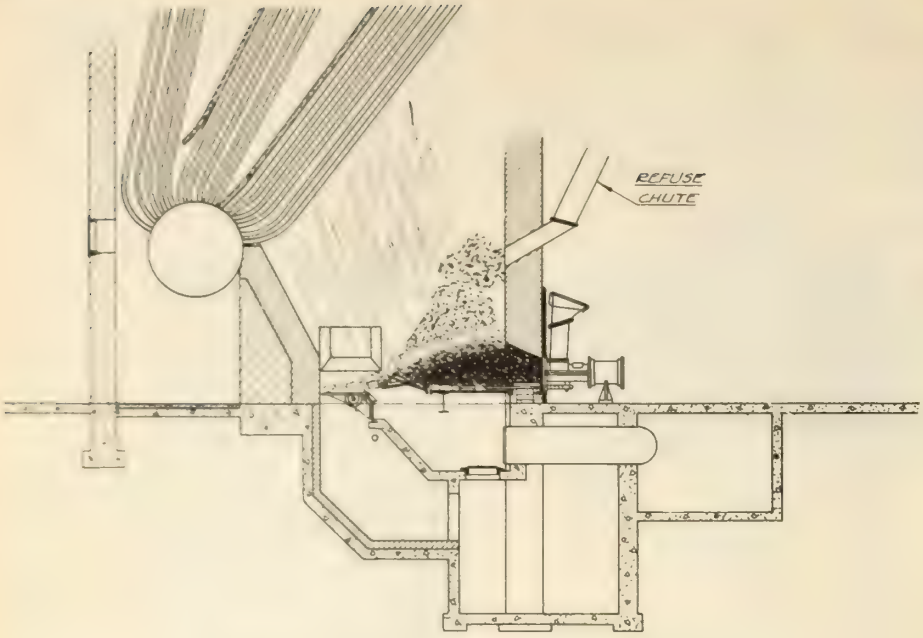


Fig. 5.—Vertical water tube boiler equipped for sawdust.

burning "Hog Feed" there is a very large volume of flame and the per cent. of CO^2 in gases is high. It is important that there be a large combustion space not only to obtain complete combustion but also to prevent unburned fuel being carried through the boiler.

Burning "Tan Bark"

Tan bark has been used for fuel on the standard type of under-feed stoker for several years. The spent tan consists of the fibre portion of bark which has been used in the processes of tanning. It ordinarily runs very high in moisture. The heat units per pound of spent tan usually average about 9,000 on a dry basis. With 65 per cent moisture, spent tan averages about 2,655 B. t.u.

The early practice in burning tan bark was to use a large Dutch oven furnace with ordinary grates. These furnaces usually had several holes in the top and the fuel was dropped through these holes on the grates. One particular type of furnace had a grate surface 24-ft. long by 6-ft. wide and the tan was fed through about five holes in the roof. Another type of furnace had a humpback grate. These grates were sloped to the sides of the furnace, with the high point at the center. This grate provided increased area, at the same time diminished the maximum thickness of the pile of fuel, (the feed holes being located over apex of grate) and thus insured a free air supply. A common trouble in these types of furnaces is the formation of air holes and the rapid burning away of the fuel next to the side walls which results in a large leakage of air from the ash pit.

For burning spent tan bark in large quantities with under-feed stokers it is necessary to have a Dutch oven with a comparatively low arch. The bark is fed onto the top of the oven usually by a conveyor, and dropped through feed holes either directly by conveyor or by hand on each side of the furnace. The bark piles up on the dead plates against the side walls leaving an open space over the stoker retort. A small quantity of coal is burned and the fire from it dries out and ignites the bark. The bark burns principally at the surface of the pile and over the stoker tuyeres. The bark is light when dried and will not stand a high air pressure. In this type of furnace it is possible to burn very large quantities of the bark and get good boiler ratings. Figs. 6 and 7 show the application of stokers to furnaces for burning tan bark.

At one plant it was possible to operate a 100 h.p. return tubular boiler at 188 per cent of rating. This required only 188-lb. of coal per hour and 2,400-lb. of tan bark per hour.

At another plant, where they do not have a very large quantity of bark, it is burned by feeding directly through the hopper, one shovelful of coal is fed in and then about seven shovelsful of tan bark. The stokers are set directly under the shell of the horizontal return tubular boiler and there is no arch. The stokers burn about 50 cu. ft. of bark per hour in this manner and consume the entire week's supply in about two days.

Burning "Sawdust"

Sawdust and shavings are available at most woodworking plants and have been common fuel supply for both

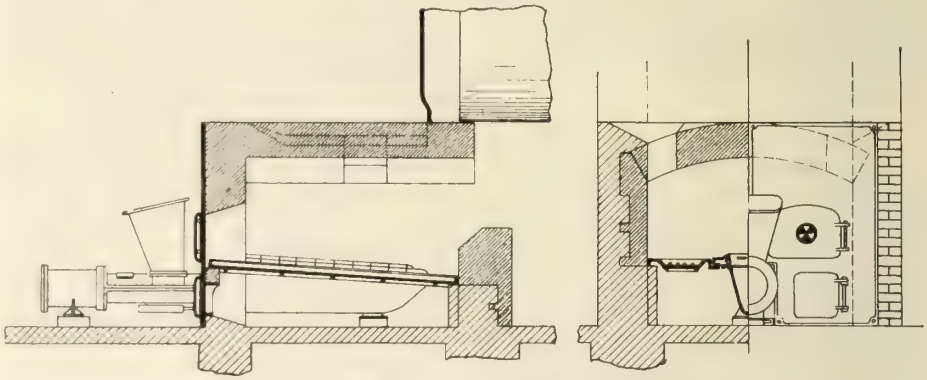


Fig. 6.—Return tubular boiler equipped for tan bark.

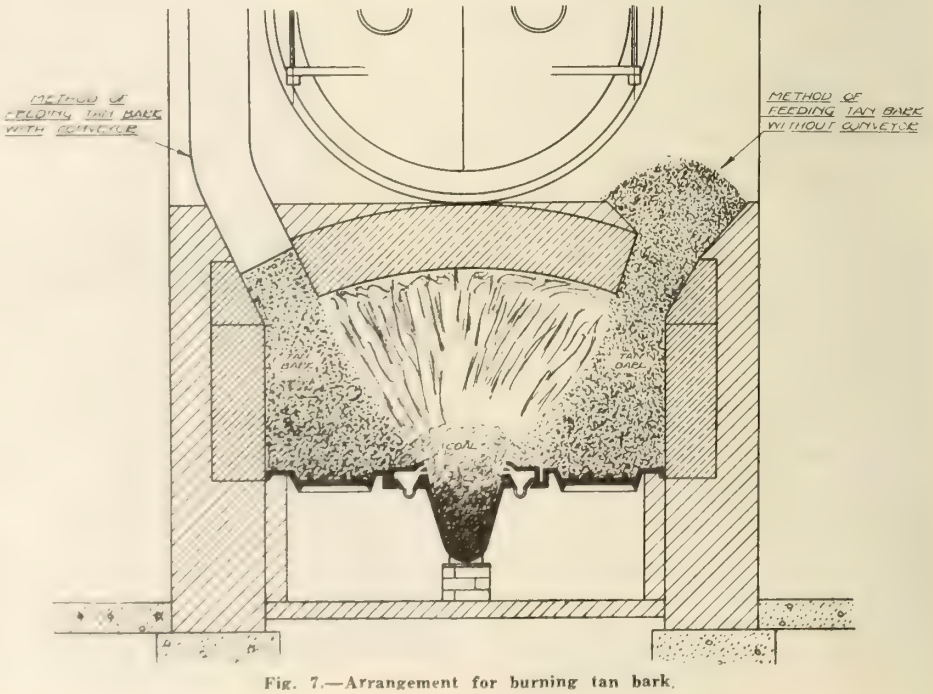


Fig. 7.—Arrangement for burning tan bark.

hand cleaned and automatic cleaning under-feed stokers. In burning this fuel no particular setting is required. The fuel can be burned in the ordinary coal burning setting, although best results are obtained when having a large combustion space. In the larger plants the sawdust, shavings and some of the hog-

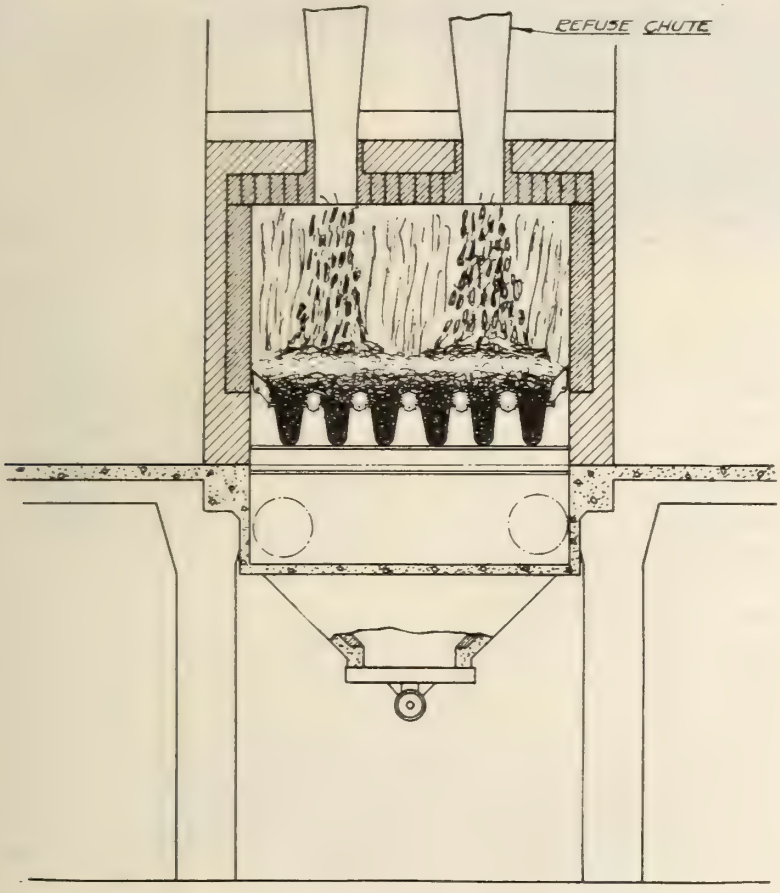


Fig. 8.—Equipment for burning hog fuel.

ged material is elevated to an over-feed receptacle by cyclone blowers and the fuel is then dropped by gravity through spouts which enter into the front of furnace.

At one plant where the automatic cleaning type of stokers are installed about 75 per cent of the refuse is burned in suspension, it being necessary, of course, to burn coal at the same time. At this plant the wood refuse supplies about one-half of the heat delivered to the boiler. Fig. 5 shows a water tube boiler equipped with stoker for burning sawdust and shavings.

At a few plants drug refuse is being burned. In one plant the stokers are set in a Dutch oven and the drug refuse is dropped in through holes at the side of furnace onto the dead plates. At other installations the refuse is fed through the door and piled on the dead plates.

Husks, hulls and chaff are available at food cereal plants and can be burned in a manner similar to sawdust. There is also considerable heat value in nut shells and this material can be readily burned. In fact furnaces can be designed to burn practically any kind of refuse that has heat in it. The under-feed stoker is especially adapted for burning refuse material due to the fact that a hot coal fire can always be carried under the material drying it out and igniting it. There is no tendency for the refuse material to smother the coal fire due to the under-feed method of feeding the coal. Under-feed stokers make the power plant operator more independent of the fuel supply, as it is possible to change quickly from burning refuse to straight coal.

DIESEL ENGINE USERS' ASSOCIATION

At the last meeting of the Diesel Engine Users' Association, held at the Institution of Electrical Engineers, Mr. Oswald Wans, A.M. Inst. C.E., M.I. Mech. E., read a paper on "Some Recent Developments in Mechanical Injection Oil Engines Using Heavy Oils." The author dealt with some of the outstanding developments of two and four-cycle mechanical injection engines which had been instrumental in rendering these prime movers efficient and reliable. In connection with two-cycle engines reference was made to the light-load running gear adopted by Vickers-Petters, Limited, by means of which a portion of the fuel is injected well in advance of the main charge, thus giving the pilot charge time to vaporise before the entry of the main charge. Fuel consumptions as low as about .55 lb. per brake horse-power hour—equivalent to a brake thermal efficiency of 25 per cent.—were mentioned as having been obtained with a fuel of about .9 specific gravity and 18,300 B.Th.U. per pound. Discussing four-cycle engines, the author referred to the advantages which had accrued from the adoption of increased compression pressures, and gave particulars of the performance of a Ruston and Hornsby engine with a compression of about 425 lb. per square inch.

The general progress made with solid injection engines during the past five years had been marked, and there was good reason to believe that the limitations of the high-compression mechanical injection oil engine had not been reached. Already engines were built developing a maximum power of 200 brake horse-power per cylinder, with a brake thermal efficiency of 35 per cent. at working load, and one might confidently expect to see in the near future multi-cylinder engines developing 800 to 1000 brake horse-power.

The further development of the oil engine, whether of the mechanical or air injection type, was largely dependent upon the materials at the disposal of the designer, and the production of metals having greater heat-resisting properties demanded the close and continued co-operation of the engineer and the metallurgist.

The Engineering Experiment Station of the University of Illinois, has issued a bulletin, No. 124, entitled "An Investigation of the Fatigue of Metals." This is a progress report of the first part of the investigation, having for its object the determination whether or not there exists any clearly defined relation between static properties and ability to resist repeated stresses. It having been decided not to enter the field of non-ferrous metals at this time, a series of tests of materials well scattered over the field of ferrous metals was made, and in most cases two or more distinct heat treatments for each metal were studied. The results of the tests, and the conclusions to be drawn therefrom are given in the above mentioned bulletin, copies of which may be had without charge by addressing the Engineering Experimental Station, Urbana, Illinois.

Hoping to find oil for several years past the Commonwealth Government of Australia has offered a reward of £50,000 to the discoverer of a payable oilfield in Australia. In addition the New South Wales Government offers a reward of £10,000 for the production of the first 10,000 gallons of natural mineral oil within the state. The oil position at present is that scouts are out in almost the whole of the four quarters of Australia hunting for the faintest indications of its presence, and bores have been put down in places where favorable features have been located.

Member of the Audit Bureau of Circulation

POWER HOUSE

JANUARY 5th, 1922

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

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Our Plans For 1922

"POWER HOUSE" wishes its readers a "Happy New Year," and takes this opportunity to lay before them some of its program for the year 1922. The readers of a paper such as this have many diversified wants, but all tending in the same general direction, and in order to cover as many of the leading subjects as possible, we are introducing a series of special articles which will appear in each issue throughout the twelve months.

These articles are divided between four subjects, which will have six articles each. They are as follows: Six articles dealing with the internal combustion engine, six articles on refrigeration, six articles on combustion and recording instruments, and six articles on heating and heating apparatus.

In addition to these articles, a series of articles by Robert June dealing with the absorbing question of power plant costs will be run and should prove of great interest to all engineers who are in executive positions or aspire to same.

We hope that the "Question Box," which has proved such a popular department in the past, will continue to be of service to the readers of "Power House." As a matter of fact, it depends entirely on readers themselves as to whether this department is helpful or otherwise. All the queries that are answered in this section of the paper are actually sent in by readers, and if these queries do not come in, the section is omitted. We know that in some journals if the questions do not come in from the readers that the staff propound questions and answer them in order to fill up the space. We feel that no useful purpose can be served by such practice, and indeed have so far had no occasion to resort to it. At the same time we feel that for readers in general, as well as those who send in the queries, this department is one of the most useful in the magazine.

Another department which is devoted to the personal use of the readers is the "Operator's Point of View," which is open to any reader who has an idea to share, or a question to bring up which is of interest to the engineering world. There is at present a discussion going on which seems to have evoked considerable interest, on the question of the adoption of a "Dominion" certificate.

We started this discussion because it has always been our opinion that the system of local certificates was a burdensome one, and a Federal certificate would be better all round. The character of the letters coming in, a number of which appear in this issue, show that there are others who share this opinion, while of course the other side has been heard from. The general developments in the engineering world as disclosed in the discussion of the technical societies, and available in the form of papers read, will be published from time to time, when the discussion is of interest to power plant men. These papers are usually prepared by gentlemen of very high standing in the engineering world, and therefore are well worthy of study by those interested in the subjects treated.

With the foregoing we hope we have outlined a program that will interest our present readers and bring many new ones into the circle. We will be in the future, as in the past, always open for suggestions or criticism from our readers, which will receive our earnest attention. The success of a magazine depends as much on its readers as on its publishers. Each must do their part. Gentlemen, let us go forward together, improving our standards as we go, so that at the beginning of 1923 we can look back on a year of good work, and forward to a year of better.

SOME LEADING ARTICLES IN THIS ISSUE

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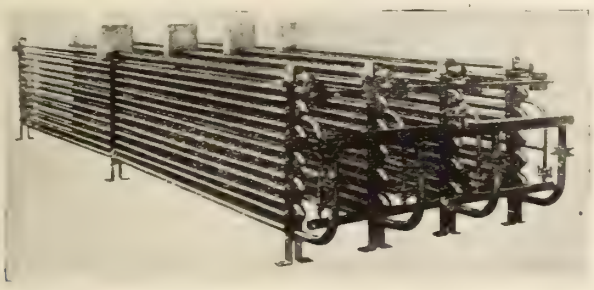
Progress in New Equipment

PREVENTING AMMONIA LEAKAGE

Ammonia leakage, if for no other reason than the loss it represents in dollars and cents, is serious enough to demand attention, but because such leakage involves danger to human life, it is of utmost importance that every precaution be taken to avoid the possibility of trouble.

Most engineers are familar with the usual construction of joints in ammonia lines, and in the return bends of condensers. Joints at many points in the ammonia system can be eliminated. There are points, however, in present construction which can probably be improved. For example, where welding can be used, it is advantageous to do so, because it overcomes the necessity of a joint and eliminates the chances of leakage at that point.



A Stand of condenser coils.

A still greater insurance against ammonia leaks is claimed in the condenser coils manufactured by the Superheater Company, Limited. The feature in these coils is the return bend. In this bend no threaded, electrically or acetylene welded joints are used, and still the return bends are actually stronger than the body of the pipe of which the condenser coil is made.

This return bend is a forging formed in a special forging process out of the metal of the pipes themselves, by means of a special forging machine. By means of this construction, a continuous pipe from inlet to outlet is possible and at the same time, the shortest possible return bend is effected without excessive pipe friction. Cross sections taken through the return bend discloses that there is no reduction in cross section area of the bend.

It will be readily appreciated that a greater cooling area is possible within a given space than is found in any other type of condenser coil.

Another advantage of this construction, is, as will be noted from the illustration, that only one valve is necessary on each header to control a unit of four stands, instead of three valves on each stand, which are necessary with built up coils. The elimination of valves means the elimination of other points where leakage might occur, and the leakproof feature of these coils eliminates the necessity of shutting off a coil for repairs.

Another advantage of this construction is the fact that because of the close spacing of the pipes, the drip strips ordinarily used to facilitate even water distribution are found to be necessary only between the water trough and the top pipe.

These coils can be made to practically any specification and are tested to not less than 800 lbs. hydrostatic pressure before shipment.

Showing Return Bends

NEW FLUE GAS FILTERING SYSTEM

Every boiler operator familiar with CO_2 equipment knows that the first requisite for successful operation is cleanliness and complaint is sometimes heard of the time required for blowing out the gas sampling lines and keeping the mechanism in clean condition. Realizing this situation the Uehling Instrument Company, 71 Broadway, New York City, have been experimenting with many substances to perfect means for completely excluding soot and dirt from the gas sampling line.

Finally a material combining the necessary porosity and refractory qualities was found and this is now embodied in the new Uehling "Pyroporus" filter "A" which is placed on the inlet end of the gas sampling line inserted in the flue or last pass of the boiler furnace. This filter consists of a heavy but highly porous disc held in a cup-shaped casting by means of a bolt. It is not injured by very high temperatures.

Formerly the gas was withdrawn through an open-ended pipe and the filtering was accomplished with cotton waste; this necessitated more or less blowing out of the gas line and required frequent renewal of the filtering material. With the new arrangement, the soot builds up on the "Pyropous" filter and does not appear to enter the pores to any extent, in fact many of these filters have been in service for months without ever having been blown out or replaced and without apparently offering appreciable increased resistance to the gas flow.

It is not yet known what life may be expected of these filters but present indications are that they will last for several years without any attention whatsoever. They are, however, inexpensive and are easily replaced. To facilitate inspection and replacement the manufacturer has also developed a frame to be inserted in the brickwork and a holder for the sampling pipe. It is quickly fastened in place by two bolts. By loosening the nuts on these two bolts and by unscrewing the union at the bottom of the section of sampling line, it requires but a moment to withdraw the filter through the frame. The frame is the width of two bricks hence it is a simple matter to insert it in the setting without cutting a large hole in the brickwork. When the sampling line is to be inserted through a metal casing,

(Continued on page 40)

The Operators' Point of View

INDICATOR DIAGRAMS

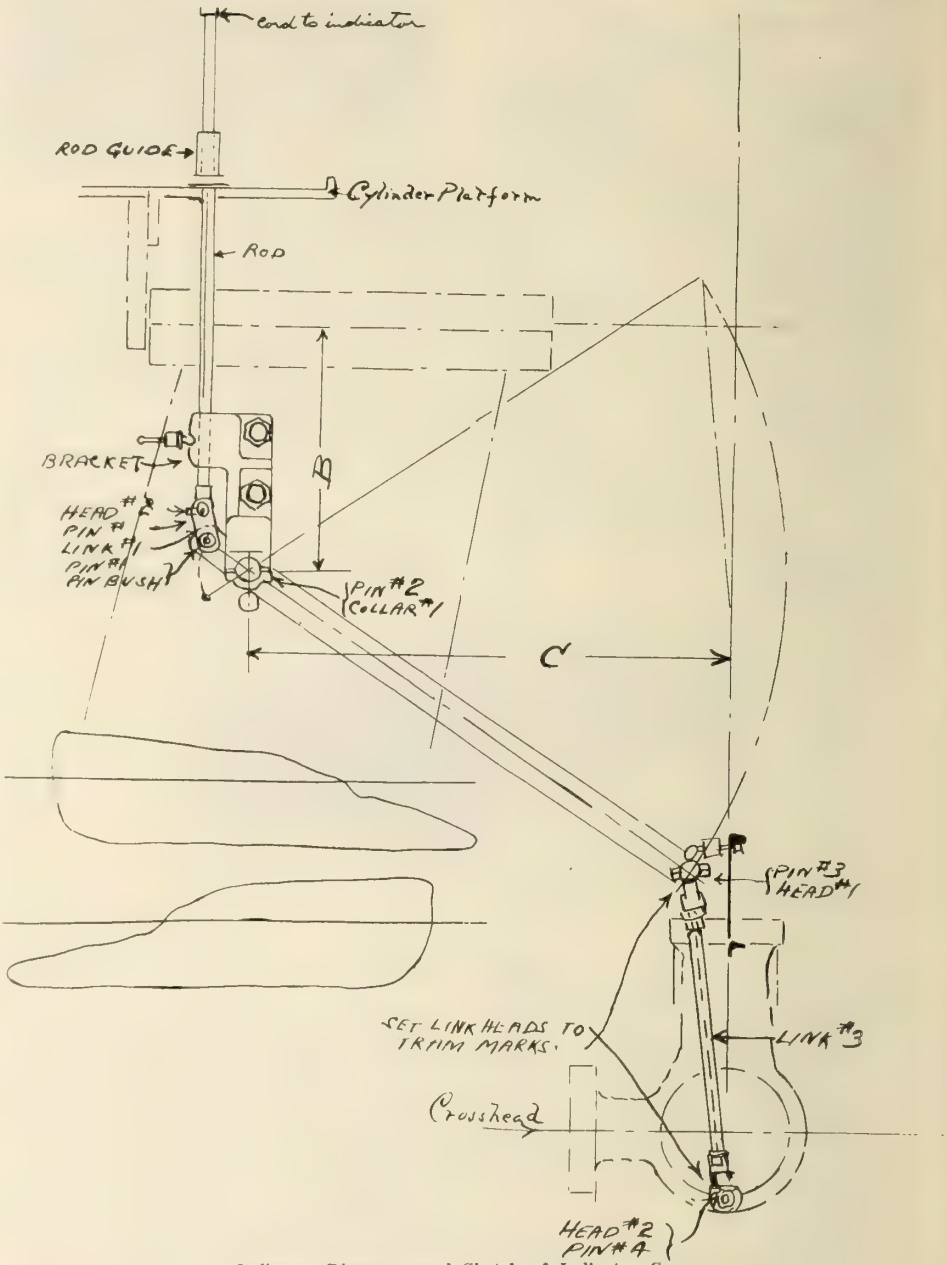
The Editor,
"Power House:"

In your issue of Nov. 21st, I took notice of a pair of indicator cards which had been drawn without lifting the pen. This may have been done using a carbon copy between the original and the copy, but what struck me more forcibly than anything, was the rise in the expansion line. Our Editor places the fault on the indicator, probably this may be right, but there is another answer to that as well. A very uneven and fluctuating load will sometimes cause that to appear on a card, when a short circuit, or "flash over" has occurred on the generator, during the time the card was being taken. This is an opportunity for the opening up of some very useful discussions, and I am contributing two more cards with the expansion lines forming indentations. Some probably would put it down to indicator fault, I did so myself at first, and changed the indicators. I was setting valves on the different engines, after repair to links, etc., and had four indicators in use, on both the engines, low pressure cylinders, I got the same result. After a careful search, I found the indicating gear attached to the engine was the cause. Our Editor has had considerable experience with the same class of engine, probably he can give us a few points on the subject. I enclose sketch of indicating gear and point out the fault in same which in my opinion might be altered to a more positive motion. I think if the long rod was carried to the full extent on the crosshead side, instead of having the small rod between, and have the long bar slotted to take up the tangential curve, the same could be done on the other end of the rod instead of links, we should have a more positive transmission of forces, I think you will agree that any slight play in the pin on links will show itself, when in its two extreme positions. I am not trying to explain the action from a dynamic point of view, but from a plain, practical engineering standpoint.

Yours truly,
Henry Wright.

Editor's Note

In the case of a sudden rise or drop in the expansion line of an indicator card I am convinced that any lost motion in the gear can cause it. The tendency for any distortion of a card through lost motion in the indicator gear is to distort the card at either end.



Indicator Diagrams and Sketch of Indicator Gear.

As the gear moves in one direction throughout the stroke, any lost motion will naturally be taken up at the beginning of the stroke in each direction.

A sudden load coming on the engine during the expansion stroke such as Mr. Wright mentions would tend to a momentary rise in pressure causing a hump in the expansion line. through holding the piston back during a small instant of time before the momentum of the flywheel came to the rescue.

Suppose the drum of the indicator did not revolve at all during the expansion stroke, the line traced would be a vertical one, from the initial pressure height to the final pressure height. Any momentary stoppage of the drum through lost motion in the gear during the expansion stroke would show a straight drop from the expansion line curve, the curve resuming at the lower level but in its natural direction. When on the other hand the expansion curve stays

at the same level for a definite space of time, making a line which is horizontal, or if the curve raises above its level, it seems to me to indicate definitely either a holding up of the piston through some mechanical cause, or through a sudden increase of pressure due to a momentary increase in the load on the piston.

In indicating engines with the gear here illustrated by Mr. Wright I have never had any experience of a hump such as shown on the cards in the illustration.

Re Mr. Wright's suggestion as to the slotting of the link to avoid the complication of swinging links, I think this might be done, but think that in this particular gear the wear on the pin and slot would be greater than in the arrangement shown. Mr. Wright doubtless remembers the indicator gear on marine engines, where the only support was a pin on the back column, the indicator bar being slotted where it went on the crosshead, or else two bars are used, with a telescope arrangement to take up the movement caused by the radius of the indicator rod. In the case of the low pressure cylinder, the air pump levers furnished a convenient means of reducing the crosshead motion, without any other reducing gear.

Have any of our other readers some experience along these lines to help the discussion?

DOMINION WIDE CERTIFICATE

The Editor, Power House.

I thank you for your small editorial note on page 38 of last issue of Power House, and will try and refrain from any future personalities. I do not think in my letter of this issue that any fault can be found with the tone, and I will promise to refrain from such bad habits in the future. I thank Mr. Noble most sincerely for his kind remarks on my behalf, he like myself, has seen the futility of indulging in personal and childish criticism, for it not only is the cause of young engineers being afraid to air their experiences in public, but leaves a bad taint in the public mouth, with regard to engineers in general.

I am following with interest the discussion which is appearing in Power House under the title of "Dominion wide Certificates," and think if this could be adopted would be a boon to engineers of Canada, but until you can destroy the petty jealousy of the younger grade of engineers, it will never mature. I don't wish to appear pessimistic in the assertion but, I make the statement boldly, knowing full well that I shall bring an avalanche of protests and abuse on my poor head by so doing. The reason our stationary engineers are in the position which they today hold is through lack of education. This causes ignorance, and through ignorance comes petty frivolities in our bearing to each other. Do away with these and you will form more of a spirit of "Camarade" between the different provinces. This may be brought more forcibly to our minds by the few words spoken of in Mr. Moore's letter of Sarnia: "The engineer who is well up in the standard of perfection has a certain amount of pity and in some exceptional cases, contempt for his brother engineer who is not so fortunate, also the engineer who passes a more strict examination in Ontario, holds the engineer of Quebec in the light of pitying patronage," and so on. Now, take the higher grade of engineers. Do they piffle with one another over trifles? Decidedly not. They cover up one another's faults like doctors, etc., do. This should be the stationary engineer's standard also. I am merely writing this article to set up a good controversy, and I hope the aftermath of these discussions will cause the powers that be to sit up and take action.

I would like to make a suggestion in regard to Mr. Goepel's letter. A man leaving and going to another province could always have a copy of his examination papers forwarded by the inspector of the province he has just left, to the one he is going to, and this set of papers could be passed from province to province as the engineer in question moved about, the original papers to be kept in the office of the province in which he first passed. This would mean a little extra work for our provincial examiners, but in the interest of the engineering community I think they would not mind, especially if a little extra remuneration was added, and the provincial government could well afford that, from the amount of money they gather each year from the various license holders.

There is at present a scheme on foot for an inter-provincial set of regulations as regards boiler construction. This was printed in 1920, and I have a copy before me with the names of the different delegates at the conference. This set of regulations in general is combed from Lloyds' rules and regulations, and if this can be carried through why not the nation-wide certificate? I shall await with interest any further discussion on the matter.

Henry Wright, A.M.E.I.C.,
Montreal Tramways Co.

The Editor, Power House:

In your issue of November 21 I read a letter under the heading of "A Challenge Accepted." Now I think the reason a great many of us do not attempt to answer such queries is that we do not feel ourselves competent to give a thoroughly correct answer, and such being the case, we would much rather not write at all. By being mum on the subject we are much better listeners to the sayings of wiser men than ourselves and we gain knowledge thereby. As regards the argument re a "Dominion-wide Certificate" I do not think our Editor wished to convey the impression that any of our examiners were dishonest, only that such might be the case. Last winter I was in charge of one shift in a factory power plant, there being two other eight hour shifts under a separate engineer. Now one of these men held a licence, the other did not. One day we were visited by an inspector on my shift. The manager accompanied him, and I heard the manager tell the inspector that a certified man was in charge of each shift. Now that inspector is an honest man but he was misled as many others are.

I also read on page 38, Dec. 5th. issue, the Editor's note. He is right, gentlemen, as to that other correspondence. One letter was mine and I have been ashamed of it ever since and hereby apologize to those to whom an apology is due. Let us all be friendly and thereby help our paper.

W. H. Long.

The Editor, Power House:

We have read many comments upon the Ontario Certificate. Now comes forward the idea (which is a good one if carried out strictly) of the Dominion Wide Certificate. I am expecting to see many letters expressing the pros and cons of this idea in future issues of Power House.

May I express my view? To me, the engineering profession in Ontario is not looked upon as it ought to be, the Engineer is not given the credit he should be, that is to say, that our employers, in the majority of cases look upon us as shovelers of coal, belonging to an uneducated class with a "strong back and weak mind" and offer us pay in accordance with their views, for, what is the average pay of a 2nd class Engineer? Take this case that I know of. The Engineer works 10½ hours per day. He does his repairs outside of this time for which we will make an allowance of 1 hour a total of 11½ hours daily for which he receives $5.00—a magnificent sum of 43.48c per hour.

Another position I applied for myself. The manager offered me $30.00 per week. I had to do my own firing, with shavings, to have steam up ready to start the engine at 7.30 a.m., shut down at 5 p.m., I would then have to do what cleaning was necessary. Work until 1 p.m. Saturdays and wash a boiler every Sunday, repairs to be done outside of this regular time without pay—probably in all about 75 hours per week or 40c per hour.

Since then I understand the pay has been reduced to $27.50.

Is this a position for a 2nd class Engineer? Is this 2nd class Engineers' pay? We buy books of a technical nature, (when we can afford it) we subscribe for technical publications and perhaps we attend technical school. While at work we use the knowledge thus gained to try and save our employer dollars and cents. Why? So that he may pay us the princely sum of 43.48c per hour.

Just today I was studying an article in Power House, "How to make use of Logs," and paused long enough to ask myself the question, Is it worth while? When one knows that the men who empty the garbage for the city get 60c per

hour, carpenters and bricklayers over 75c, have we not the right to pause and ask, "Is all this study worth while?" Under the existing conditions I would say, "No."

We must have 10 years' practical experience before we may have the privilege of writing for a 1st class Certificate, then we must pay $10.00 for that privilege and $2.00 per year for renewal.

What is the cause of our position?

1. Too many Certificates issued (without examination) when the graded law became effective, resulting in a large number of men holding certificates who, if now asked to pass the required examination, would utterly fail.

2. A large number of Engineers are holding positions which call for a Certificate one grade higher than that which the Engineer possesses simply because they happened to be in that plant previous to the new law becoming effective.

The majority of them will hold their job "until the boiler busts," they are a hindrance to the man who is anxious to get ahead, because (a) they draw pay for the Certificate they hold, which is a grade lower than the job calls for. This satisfies the average employer and tends to keep the wages down elsewhere because (b) an Engineer with the necessary Certificate cannot get a position that his Certificate entitles him to because the fellow with the lower grade has it.

3. Lack of strict enforcement of the Law.

Regarding No. 1, I claim that every one should have been required to pass their examinations for the Certificate they were granted within a year or at most two years after the coming into effect of the Act thereby giving everyone a fair chance and no one getting favored accidentally or otherwise.

Regarding No. 2, each Engineer who is thus situated ought to be compelled to qualify for the grade of Certificate his position calls for or relinquish said position in favor of the man who holds the required certificate. A certain firm in this city has a power plant of approximately 800 B.H.P. A Chief Enginner in charge with four assistants on 8-hour shifts, three of these assistants carry 3rd class certificates because they were there when the Act came into force, the fourth has 2nd class papers, he was hired after the Act was passed and was therefore required by law to have a 2nd class, yet he had to work at the same rate of pay as the man with 3rd class.

Is this right? I do not wish to insinuate that a man holding 3rd class knows less than one holding 2nd class for sometimes the case is reversed, then in that case why doesn't he "scrap" his 3rd for a second?

Regarding No. 3, there have been some new laws passed governing Engineers which are a little stricter. A rigid enforcement of these laws would be one of the greatest boons to the engineering profession, (I use the word Profession because that is what the "trade" ought to be called) that can ever come about. In conclusion, I say, let us have a Dominion wide certificate. Let us have a Dominion Wide certificate. Let than than the late election. Let us have a still stricter law, a stricter examination and a more rigid enforcement, all these can be incorporated under "A Dominion Wide Certificate." If we get these then we may know that although we get only 43.48c per hour now, in the future we shall be rewarded.

Ten years is too long to wait for a 1st certificate. Ten dollars is too much to pay at the present rate of pay and the standard of the certificate is too low.

The Dominion Wide idea should appeal to all. Minor differences that might exist between provinces could easily be adjusted to suit all.

There are a good many engineers that when the 2nd or 1st certificate has been gained they would have something worth while.

Reading in Power House a report of an address given by Mr. Brown, Chairman of the Board of Engineers, at a banquet given by the C.A.S.E. he remarked that he hoped to make the Ontario certificate second to none. We can achieve this by the Dominion Wide Certificate.

"Hygrade"

The Editor, "Power House":

I have read with interest your editorial in reference to this matter, also letters replying to same by Mr. P. Goepel and Mr. F. Moore.

Mr Goepel writes that "permits or temporary certificates are very seldom granted." Ten years ago or even less, I could have agreed with this statement, but not at the present time.

Less than two years ago I was engaged as a shift engineer in a plant in B. C., having a boiler H. P of about 300 and equipped with steam-electric and Ice-making machinery, deep-well pumps, etc.

At this time there were many qualified engineers holding certificates available as times were dull. Notwithstanding this fact, a man with a temporary certificate good for six months was engaged at a salary considerably higher than the average paid in the province at that time.

He admitted to me, amongst other things, that he had never filled a sight feed lubricator, and did not know how to do it. Still he made it stick for the six months—the chief being about on a par with him thought he was O. K.—after which time he quit rather than try the examination which would be required of him if he was to be allowed to continue. A flunkey around the institution then obtained a temporary certificate good for twelve (12) months. He also pulled out in time to escape the examination.

Neither of these men were engineers, nor was the man in charge of the plant who is the holder of a third class certificate, and who pulls off such stunts as sending a motor away for repairs without knowing what was the trouble, when all that was wrong, was, that he had allowed one of the bearings to go dry on his own shift, causing it to seize the shaft stopping the motor. When asked by the electrician what was the matter with the motor, he replied, "that is what I sent it to you to find out."

Now the point is this. None of these men were entitled to have permission to operate power plants. Why they had such permission is beyond me. All three are returned soldiers, and obtained their certificates since they were discharged from the army.

What I consider as one of the faults with regard to the issuing of certificates to engineers in B. C., is, that a part of the examination is verbal, there not being sufficient written record of the candidate's qualifications kept to prove that a certificate ought to be granted to him, with the above mentioned result.

In Saskatchewan the whole of the examination is a written one. Not necessarily in the presence of an inspector of steam boilers, I wrote mine in the office of the Deputy Minister of Public Works. The work was then sent to the chief inspector of steam boilers and machinery and kept as a permanent record. This, I consider a far fairer and more thorough method as regards a Dominion Wide certificate no greater expense than that envolved at present is necessary, as the candidate could write his examination in the presence of any responsible government official and the work forwarded to a qualified examiner to be examined and passed upon.

I believe also that 3rd and 4th class certificates could well be dispensed with, shift engineers being allowed to operate under a holder of a 1st or 2nd class certificate, the examination for such certificate being of such a standard as would assure the holder's ability to judge as to whether a man can make good as a shift engineer or not.

J. G. Livingston,
Kamloops,
B. C.

The Editor, "Power House":

Permit me to express my opinion on this very interesting discussion. It is interesting to me for this reason that I do not possess any Canadian certificate, although, (pardon my egotism) I might have half a dozen of them if I cared to. Personally I do not think that Stationary Engineers' Certificates, as I know them, are worth the paper they are printed on. I have assisted, and coached more than a dozen young men to procure them and am doing so at the present time, but, after all, and plus a certificate, this will not make them engineers.

I remember some years ago, when I was at sea, a young man with his chief's ticket, (I was on watch with him as

junior) putting a hose on to a hot eccentric strap to cool it, with the result that the eccentric connecting rod 5in. in diameter broke 12in. above the strap causing considerable excitement and, incidentally, damage in the engine room. At the enquiry which was held after we got to port (I was one of the principal witnesses) I was asked by the Superintendent, "If I did not know anything that was better than a hose for a hot strap, and what I should have done under the circumstances?" I told him what I thought should have been done. He (the super.) then gave the chief a lecture, which I have never forgotten and told him always to remember, that although he was chief, that there were probably better engineers round about the engine room than he was. Needless to say that chief did not sail with us next trip. I have mentioned this to show that a certificate is not much good unless you have considerable experience to back it up.

I am of the opinion that a Dominion Wide Certificate would be the best, for at least one reason. Supposing, as was the writer's experience, that a position is open, say out somewhere in Western Canada and an engineer, say in Nova Scotia applies for it. This engineer has been in Nova Scotia all his life and possesses 1st class N. S. papers. How is the engineer to know if his N. S. papers are the equivalent of the papers out there in Western Canada? I have heard it said that N. S. papers might land a good fireman's job up in Ontario, I took this with a litle salt, of course. I am personally acquainted with several good N. S. engineers up there. Would not a system like the British Board of Trade be better, where every ticket has the same value all over the world? The question of identifying the holder of a B. O. T. certificate is easy. Any engineer knows that there is marked on his Discharge Certificate, his name, where born, height, complexion, peculiarities, tattoo marks if any, color of eyes, hair, etc. So that any one trying to get by on a certificate not his own, has a job to do it. If a certificate is lost, and is found by anyone, he is instructed (on the ticket itself) to return it to a certain address, or to the nearest Board of Trade Office where a substantial reward is paid to him for its return. I have myself, lost my own, on two occasions in one of the largest shipping ports in Britain and have had it returned to me by the B. O. T. officer when "signing on" for our next voyage. Something then along these lines would be a help towards a better system of dealing with "unknown quantities." I remember shortly after I came to Canada and even although I had a certificate from the British Board of Trade to show my "bona fides" as an engineer I wished to get Canadian Papers. I was informed that I must first get a third class ticket, wait for a year, get a second class ticket, then wait for another year before I could take 1st class papers. I got into communication with the Chairman of the Examination Board and enqiured if it were not possible for me to take a 1st class examination at once. He informed me that I could not, and that the above regime was in force. Formerly, he said, it could be done, but not now, I would probably have to get permission from Ottawa for this and would have to pay all the expenses of a special examination. This I took to be rather hard lines, and have not bothered with it since. A system should be recommended so that anyone could take an examination for 1st class papers at any time, and anywhere, provided he can show the Government Examiner verbally that he is fit to do so.

Mr. Goepel, in the last paragraph of his letter says, "The local conditions peculiar to themselves is one factor which would be difficult to overcome with an All Canadian Certificate." This is probably correct, then why not an examination extensive enough to cover all kinds of plants? That is, at least for 1st class papers. There is a great difference between logging camps and municipal lighting, coal mines and shipping and so on, but all generate steam in a boiler. Hence the usual boiler questions would remain. The modern tendency now is the Turbo Generating Plants and Electrical equipment. I do not recollect having seen any questions along these lines, at least not in this province, for the past eight years. In the "Old Country" things are done differently. Before anyone can go after a certificate he must first have served his apprenticeship of 5 years as a "fitter" (called "machinist" in Canada) before he can even get a job in an engine room. Here in Canada anybody can go and sit for papers and get away with it, and the result is mediocrity. I am speaking from personal experience with this class. A young man in this district ran away from home here and went to London where he got a job on a ship as a greaser (oiler). After making a trip or two, when he found that he could not "rise to be an engineer" he gave it up and came back home again. He found out that engineers were not made that way, at least, not in the Old Country.

If anyone will look through any British Technical journal and see there an advertisement for an engineer, he will invariably find added to it: "Marine Engineer preferred." Why is this? The advertiser knows that a marine engineer has been properly trained and examined and that there is no doubt about his certificate as stated above.

I do not wish to be misunderstood. I am not trying to compare the British Board of Trade certificate with the Canadian certificate and, I think, anyone who has had experience with both, will understand why. I only wish to point out that a Dominion Wide certificate in the lines of a British Board of Trade certificate would be a far better arrangement than the present system.

J. W. C.

A CHALLENGE ACCEPTED

The Editor, "Power House":

Under the heading, "A Challenge Accepted," Mr. Wright replies to a former lettter of mine which was printed under the heading "A Challenge," which was not written with that idea in view but for an entirely different purpose. However, the purpose has been accomplished.

Mr. Wright's letter deserves an answer.

In the first place, I was not complaining of lack of courtesy by Mr. Wright in not replying to my letter in answer to his question regarding the tube failure, at least not in the sense that I wanted or expected thanks. There is another reason possible and it is the correct one.

In a letter I received a few years ago from the late Oroses C. Woolson, a New York engineer, Mr. Woolson complained of the invariable neglect of engineers when asking for help through engineering magazines to acknowledge any help given. Not that he wanted thanks for the help, but he did want to know if the help offered was of value in the case, that is, if the solution offered was correct. The pages of an engineering magazine may be used by engineers for their mutual benefit, but this benefit can be enjoyed most if those asking for help will say which solution was the correct one instead of, as Mr. Woolson stated, "closing up like a clam." It is just possible that "closing up like a clam" is what discourages engineers from offering help.

I remember Mr. Wright's question about the Rado-jet and did not answer it because I had no "guess." If Mr. Wright will be good enough to send me a copy of the reports on the tube failure I would appreciate it very much, not altogether because I want to know the right answer, but because I would like to know the process of reasoning by which they arrive at their conclusions.

In regard to my questioning such an authority as Mr. Pratt, Mr. Wright does not appear to be quite clear. It is only his common explanation that I do not agree with. Another common explanation that I do not agree with is that of the cause of smoke, viz.: that it is caused by the hot gases striking the cooler boiler surfaces, before combination is completed becoming cooled, and depositing the soot.

The true explanation as found by the U. S. Bureau of Mines, is that smoke is formed at or near the surface of the fire, and remains smoke until it either finds sufficient oxygen to make CO or CO_2, or is deposited on some part of the boiler, or passes out the chimney. There are some common explanations that ought to be in the discard.

Anyway, why should not I question Mr. Pratt's theory in so far as his "common explanation" goes and on which he does not appear to be very much struck himself, when other authorities go so

far as to say that excess air lowers the exit gas temperature, which is directly contrary to Mr. Pratt's claim?

If my action constitutes bravery what would Mr. Wright say about the latter?

Now Mr. Editor I don't think I have said anything to hurt Mr. Wright's feelings. And even if I have I know he will not call me names.

The fact that he was disheartened and even disgusted indicates that there is something wrong about the way that engineers play the game.

One thing I want Mr. Wright to understand clearly and that is that I don't subscribe to the creed "what we have we hold" and I don't think he does.

R. McLaren,
160 Dovercourt Road,
Toronto.

BOILER HORSE POWER

The Editor,
The Power House.

Dear Sir:—

The writer feels that Mr. McLaren's letter in your issue of December 5th on Horse Power and Boiler Rating was timely and of interest to engineers in general, because there are still some engineers who cannot understand the fact that a boiler of definite Horse Power will not always supply sufficient steam to an engine of equal horse power rating, or on the other hand may be made to deliver a far greater horse power at the engine shaft than the rating of the boiler.

Mr. McLaren deplores the fact that Steam Plants are rated in the way they are for the purposes of Engineers' Certificates in Ontario. Mr. McLaren apparently forgets that the term Boiler Horse Power is in any case a purely arbitrary unit of measurement, which has not been standardized by Act of Parliament or International Agreement as have the Centimetre, the Pound, the Gallon, etc. Therefore any one is at liberty to define this unit in any way he feels fit for any particular purpose, but in order that another person may know just what he means by this unit he must give his definition of the unit. This has been done in the case of the "Regulation Relating to the Examination of Engineers;" also, the B. H. P. has been defined in another way in the "Regulations for the Construction and Inspection of Boilers;" although both these publications are issued by the Department of Labor of the Ontario Government. Other provinces such as Alberta and British Columbia define Boiler Horse Power in still other ways, each for its own purposes.

Mr. McLaren seems to feel that the Boiler Horse Power unit for the rating of steam plants in Ontario should be more nearly equal to the usual builders rating, viz. 10 square feet Heating Surface per Horse Power. The writer feels that the reason for the low rating of this unit by the Board of Examiners is to make things as easy as possible for Engineers, also to prevent engineers complaining that their plant is too highly rated and that they should not be required to hold such a high grade of certificate.

In illustration of the above, consider a boiler plant with Return tubular boilers having a total of 2985 sq. ft. Heating Surface. Under the above mentioned regulations this would be rated as a 199 Horse power plant, and would require therefore only a 3rd Class Engineer in charge. However, with good firing and draft, these boilers would no doubt develop about 350 Horse Power (measured by evaporation), which with modern high efficiency engines would develop well on to 500 Brake Horse Power. All on a 3rd Class Certificate. This gives the engineer in charge no chance to complain, and gives good openings to the lower grades of engineers. Thus the requirements are not really nearly as high as they seem on the surface.

If the above plant had been rated at 14, or less, sq. ft. Heating Surface per Horse Power, it would have required a 2nd Class Engineer to take charge, because it would have worked out at over 200 H. P.

I might mention here that the American Society of Mechanical Engineers have for some years past discontinued that use of the Boiler Horse Power as a unit of capacity in favor of a standard unit of one pound of water evaporated into dry steam from and at 212 degrees Fahrenheit.

M. B. Watson.
Director of Engineering
Toronto Central Technical School

SAFETY VALVE AREA

The Editor,
"Power House,"

Dear Sir:

Having read the article in December 5th issue of Power House re "What should the Safety Valve Area Be" I think Mr. J. A. McGillivray is not applying the Canadian Interprovincial Safety Valve formulae correctly, because the boiler was not being operated under ordinary conditions (that is at normal capacity). Instead of using the formula

$$A = \frac{37.5\ G}{WP+15}$$

he should use the formula

$$A = \frac{W \times 0.22}{WP+.15}$$

for finding the area of the safety valve required as the boiler was being worked, or forced above normal rating during the test. In the latter formula

W = maximum number of pounds of water evaporated per hour
WP = Working pressure
A = area of valve required in sq. in.

Applying this formula to his figures

$$A = \frac{38700 \times 0.22}{200+15} = 40 \text{ sq. in.}$$

This area calls practically for 3-4½in. safety valves, because valves above 4½in. diameter are not allowed on high pressure boilers. The two 4½in. valves on the boiler are large enough if the boiler is not operated above 150% rating and too large for normal rating, because applying the formula

$$A = \frac{37.5 \times 110}{200+15} = 19.18 \text{ sq inches.}$$

This area requires 2-3½in. valves and two 3½in. valves have a relieving capacity of 22200 lbs. per hour and at normal rating the boiler would only require to evaporate $34.5 \times 600 = 20700$ lbs. of water per hour.

Applying the formula

$$A = \frac{W \times 0.22}{WP+15}$$

to his last problems, (If A=201 sq in.) to get an area equal to 201 sq. inches with this formula the boiler would have to evaporate 197600 lbs. of water per hour because

$$A = \frac{197600 \times 0.22}{200+15} = 202 \text{ sq. in.}$$

This area would require 13-4½in. valves because the area of a 4½in. valve= 15.90 sq. in. and $15.90 \times 13 = 206.70$ sq. inches which is close enough in this case. This formula shows that when A= 201 sq. inches, the boiler would have to develop about 5700 H. P. He states that only four 4 inch valves are required when A=201 sq. inches, because they have a circumference equal to the circumference of a 16in. diameter valve. This is wrong because A has nothing to do with the circumference of the valves, but only the area. If only four 4 inch valves were required A would have to equal only 50.26 sq. inches because the area of four inch valves equals that.

Yours Truly,
W. Tattersall,
Medicine Hat.

Flue Gas Filter

(Continued from page 35)

as with a horizontal return tubular boiler, the frame is omitted and the holder is bolted directly to the metal casing of the boiler.

Aside from the great gains in the reduction of attention required on the part of the attendant by the improved arrangement, another very important advantage results, namely that a smaller pipe line can be employed because its entire cross sectional area is effective when it is kept clean. Smaller pipe is not only easier and more economical to install but of even greater advantage, as it takes less time to draw a given volume of gas through it and consequently the CO_2 recorder reflects furnace operating conditions more promptly when smaller pipe is used.

While designed primarily for Uehling CO_2 equipment, "Pyroporus" filters may be used for other makes of instruments and the frames and holders are useful in connection with pyrometers, draft gauges and for providing convenient openings in the furnace for test and observation purposes.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

VARIOUS QUERIES

Question—If the throw of the eccentric is three inches what would be the valve travel and what would be the port opening?

Answer—The throw of the eccentric is half the valve travel, just as the throw of the crank is half the stroke of the engine. The travel of the valve must be equal to twice the lap plus twice the port opening. That is starting from midposition of the valve, in order to open the steam port at either end it would have to move a distance equal to the lap. In addition to this it would move a distance equal to the greatest port opening. The eccentric would then be at its dead centre, and starting to return. When the eccentric has made half its stroke the valve will be again in mid position and as the eccentric completes its stroke, the valve opens the port at opposite end to its full extent. Thus the throw of the eccentric is equal to the lap plus the port opening, and the travel is twice the throw so that the travel is equal to two laps and two port openings. We cannot tell the actual port opening without knowing the amount of lap.

Question—What is meant by the word phase in a motor?

Answer—In an alternating current machine the leads are taken from different parts of the armature, and the total current divided up between these leads. Thus in a three phase machine suppose the circumference of the armature to be divided in three parts, then three phases would be taken off 120 degrees apart from each other. In speaking of phase we also mean the relation of current and voltage to each other. Thus the electro motive force in an alternating machine may occur at the same moment as the maximum current in which case they would be in a phase, while if the maximum values occur at different periods in the revolution they are out of phase.

Question—What is meant by CO_2 and CO?

Answer—CO_2 is the chemical symbol for carbonic acid gas, or carbon dioxide, while CO is the symbol for carbon monoxide. CO_2 is the product of perfect combustion of carbon in conjunction with the correct amount of oxygen, while CO is the resulting product from imperfect combustion. The amount of CO_2 present in the flue gases determines the efficiency of combustion, and should be from 12½ to 16 per cent of the volume of the gases.

Question—How high will a column of mercury 28 inches high raise water in a pipe?

Answer—The weight of a cubic inch of mercury, that is one square inch area by one inch in height is .4908 lbs. A column of mercury thirty inches in height will just balance the pressure of the atmosphere, which is 14.7 lbs. per square inch. The pressure due to a column of mercury 28 inches high would be 28 x .49 lbs. per square inch, practically 14 lbs. per square inch. A column of water 2.305 feet high is equal to 1 lb. per square inch pressure, so that 14 lbs. per square inch will support a column of water 2.305 x 14 which is 32.27 feet.

Question—Draw a sketch of wire drawing?

Answer—Wire drawing is the term applied to the action of passing steam through a narrow orifice with the result that its pressure is decreased by the friction it has to overcome. In a diagram such as drawn by an indicator card, wire drawing would be shown by a swiftly sloping steam line.

Question—How does a condenser affect the steam and what gain is there in using a condenser?

Answer—When a condenser is used the exhaust steam instead of having to pass from the cylinder against atmospheric pressure, is passed into a vessel where it is either mixed with water and condensed, or passes over tubes and is condensed. As steam when condensed to water occupies only about 1-1600th part of the volume it occupies as steam, a vacuum is produced in the condenser. This means that the piston instead of having to work against a back pressure slightly above that of atmospheric pressure, has only to work against a back pressure of probably two to four lbs. absolute above vacuum. The engine is thus able to develop more power for the same steam consumption, or the same power for less consumption. The gain from condensing is in the neighborhood of 15 to 20 per cent.

Question—What would be the gain in raising feed water from 40F to 180F?

Answer—Every degree the feed water can be raised in temperature before going to the boiler leaves so much less heat to be added in the boiler. If this heat can be added from a source that would otherwise be lost there is a considerable economy resulting. As an approximation the saving of fuel is equal to 1 per cent. for every ten degrees the feed water is heated.

The following formula is more exact:

$$\frac{\text{Temperature leaving heater—Temperature entering heater}}{\text{Temperature of steam—Temperature entering heater plus latent heat}} \times 100$$

Question—What is the most dangerous thing to happen to a refrigerating machine?

Answer—Probably the most likely source of a serious accident would be the carrying over of large amounts of liquid to the suction side of the machine, which would have the same effect as water in a steam cylinder. This would be caused by passing more liquid through the expansion valve than could be evaporated by the surrounding medium, thus passing liquid instead of gas through the low pressure side of the system to the suction valve of the compressor.

SHOULD GAUGE GLASSES BE CLOSED

Question:—I am running a small plant and would like to know if there is any danger of the water glass breaking. It is a portable boiler used for heating purposes, 15 h.p. with the safety valve set to blow off at 15 pounds per square inch. It is without any attendance for about six to eight hours at night and I have found that it has made steam during that time with the bottom draft shut. Do you think it would be advisable to close the cocks on the water glass during that time?

Would you also tell me which way the check valves should be set on a high pressure return system from coils and where they should be located, as we have quite a bit of trouble with the steam trap. It lets a lot of steam pass through, although we had it fixed a short time ago. It is now as bad as ever through the cutting of the needle valve. Can anything be done to prevent this?

Would you tell me the best kind of check valve to use on the delivery pipe from injector to boiler and the location for best service.

Answer:—In leaving a boiler under banked fires and without attendance for any length of time, it is always advisable to close off the gauge glass cocks. The gauge glass is no use to anybody if they are not there to see it, and there

is always a possibility of it breaking. The result of a glass breaking and not being shut off will be to fill the engine room with steam, and if the banking of the fire has not been carefully done, the release of pressure due to the escape of steam through the glass will result in more water being evaporated, and there is a chance of the boiler being overheated directly over the banked fire. As long as the engineer starting up in the morning observes the usual precaution of blowing his glass through before touching the fire, there is little chance of the cocks being left closed while the boiler is working.

Without knowing anything of the system you have, it is impossible to say anything about the position of the checks. As regards the trap leaking through the needle valve, the only precaution to take to prevent this is to see that the valve is ground to a good substantial bearing in its seat, and that the valve spindle and the link it is fastened to, if any, allow it to come down to an absolutely even seat when working. If this is not done, a needle valve under high pressure will cut very rapidly.

We cannot through this column recommend any particular type of check valve, but we may say that the best check valve to use on a boiler feed line is the best that can be procured. The only way to make a selection is to become familiar with the different makes of valves, and their particular features of construction, and then use your own judgment.

AMERICAN METRIC ASSOCIATION

The above society are holding their annual convention in Toronto this week, concurrently with that of the American Association for the Advancement of Science. The Society has for its object the standardizing of the metric system in the United States, and has at present, bills before both Federal houses, containing legislation with this object. It is not sought to make any sudden change, but provdes for a period of ten years in which to adopt the new system. If this legislation does not pass, the Society will continue to work for the adoption of the system through its various connections with industrial firms and private persons. There is a similar Association in the United Kingdom, and a large number of distinguished men in both countres have given their approval to the object sought. Mr. W. M. Crocker is the secretary of the American Metric Society, and is at present in Toronto, The headquarters of the Society are at 156 Fifth Avenue, New York. Mr. Crocker has a large amount of literature bearing on the subject, which is an interesting one, and he will be very glad to furnish anyone interested in the matter with copies of the various papers. Mr. Theodore H. Miller, Works Manager of the De Laval Separator Co. will deliver a lecture during the convention on "Transition Engineering," in which he will give details of the experience of his company in adopting the metric system of measurements in their works.

CATALOGUES

Safety Switches and Panel Boards is the subject of catalogue 12-A, dated 1921-1922, which is now being distributed by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. This catalogue is profusely illustrated with views of installations of safety switches in the shop, in the office, and in the home. Dimensions and list prices of these switches are given in detail. Some of the subjects that are discussed are the railway type safety panel boards, the safety car lighting panels, the auto-lock control panels, the dead-front and dead-rear safety switchboards, the live-front knife switches and many other devices.

We have received from the Sterling Engine Co., Buffalo, their catalogue illustrating gas and gasoline engines for driving centrifugal pumps, for use in water works, industrial plants, and fire protection systems. Several of these units have been installed in Canadian cities. The catalogue is well illustrated and all the necessary information is included. Diagrams showing the space occupied by different sized installations are also given.

The Canadian Ingersoll Rand Co., Montreal, have issued in the form of a bulletin the paper on "Steam Condensing Plants," read before the Baltimore section A. S. M. E. in May last. The paper is a very interesting one, and contains much valuable information for those interested in the operation of this type of apparatus. Bulletins 1028, 1094, 9032, and 9224 covering low level and surface and Barometric condensers are now available and will be supplied to readers of Power House on request by the Canadian Ingersoll Rand Co.

Westinghouse Turbine Generator Units are described and illustrated in Circular 1094-B, just issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This publication contains a discussion of the reactance and impulse types of turbines, both the semi-double flow type and the multiple cylinder type. Bleeder turbines and geared turbines are described, and each part of the turbine is elaborately treated.

The generator is also discussed in detail, and illustrations are given to show the latest types of construction.

The Combustion Engineering Corporation, New York, announce the opening of a new branch office at 806 First National Bank Building, Pittsburgh, Penn. This office will be in charge of Mr. C. W. Stripe, formerly manager of the Philadelphia office.

Laclede-Christy, St. Louis, have issued Bulletin No. 2, entitled, "Are Refractories Imposing a Limitation on Stoker Performance?" This bulletin discusses some of the features of refractory furnace linings, their use and abuse, and also the danger of selecting improper brick. It is well illustrated.

Industrial Works, Bay City, Michigan, is distributing free upon request Catalog No. 113, illustrating and describing the Type BC "Industrial" Crawling Tractor Crane of 20,000 pounds capacity.

This crane is pre-eminently adapted to the needs of road contractors, lumber and coal dealers, gravel, sand and stone producers, foundries, railroad reclamation and storage yards, and moderate-size manufacturing plants.

BRITISH CAPITAL AND CANADIAN INDUSTRIES

As a result of the recent visit to Canada of Mr. Ben H. Morgan, Chairman of Council of the British Empire Producers Organization, that body is now developing its Dominion industries service, particularly in interesting British capital in a number of Canadian industries. At the last meeting of council the matter was fully discussed and it was decided to invite any responsible Canadian bodies or individuals interested in such problems to communicate with the secretary of the organization at 3, Old Queen Street, London, S. W. I., England, with as full particulars as possible.

NEW FORM OF STAINLESS STEEL

The early forms of stainless steel were not such as could be easily worked, but a British firm of steel makers has been carrying on a series of experiments with a view to producing a steel which will retain rust resisting properties and can be worked without difficulty both in the hot and in the cold state. These experiments have been successful. The new plastic rustless steel can be stamped, punched, pressed, chased, or engraved cold; and it can be bent cold to a diameter equalling its own thickness without showing any signs of fracture. It may be polished silver bright, and this polish will remain in any atmosphere. In many cases a piece of this steel has less than half the weight of a brass or nickel piece of the same strength.

The Taylor and Arnold Engineering Co., have been appointed to act as dealers for the Davis-Bournonville Co., in Ontario, Quebec, New Brunswick, Nova Scotia and Newfoundland.

Mr. W. W. Avey, Norwich, Ontario, is in the market for engine, boiler and complete equipment for new planing mill.

Gropp Bros., Penetang, Ontario, are in the market for saw-mill machinery, boiler engine, belting, etc.

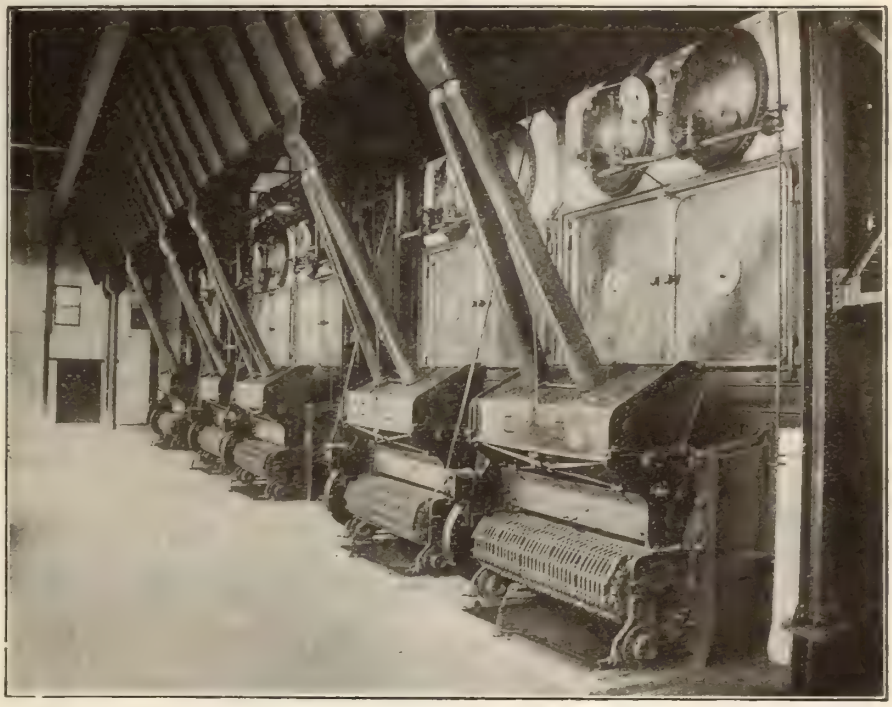
"B & W" *Marine and Land Type* Boilers

—Setting the World's Pace for Efficiency

All over the world, ashore or afloat; wherever there is steam used more than 20,000,000 H.P. of "B. & W." Boilers are taken as the standard of all that a boiler should be.

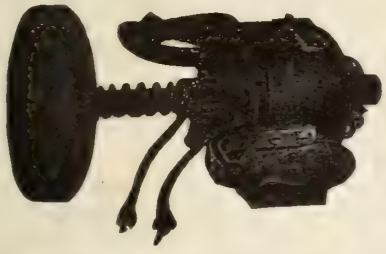
This leadership—indisputable leadership—is based on the three pre-eminent features of every "B. & W." Boiler. **Every "B. & W." Boiler is designed for the rapid, economical, and safe generation of steam up to the highest pressures!**

This degree of efficiency is attained through a construction devoid of all unequal strains—a construction which is easy to clean, easy to erect and of sufficient durability for many years of service.



Typical installation of "B. & W." Boilers with Mechanical Stokers.

Remove Scale from Tube Ends and Caps with the LAGONDA Reseating Machine



The "Lagonda" Reseating Machine, Motor Driven, Showing Emery Wheel.

When the **Lagonda Reseating Machine** is used tubes may be cleaned and caps replaced to headers with the assurance that steam and water tight joints will always result.

The **Lagonda Reseating Machine** consists of an emery or carborundum cloth wheel driven at high speed by an electric or water motor. It not only removes the obstructions but leaves the surface bright and polished so that the cap will fit perfectly.

To clean header faces the operator merely moves from tube to tube. To clean caps the machine is held in a vise. Machine is equipped with a guide ring which keeps wheel centered on tube.

Bulletin "G-1" shows the machine in use and explains its construction in detail. Write for copy.

"Lagonda" Boiler Tube Cleaners

For keeping the tubes free from scale. Water, Air or Steam Driven.

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE, BANK OF HAMILTON BUILDING

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	
1¾-in.	29 75	
2 -in.	29 25	19 00
2½-in.	44 75	22 50
3 -in.	49 25	27 50
3¼-in.	.....	34 00
3½-in.	63 50	30 50
4 -in.	85 00	40 00

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$4 25	$3 90
Plates, ¼-in. up	3 75	3 50

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	4.89	6.99	5.91	8.01
⅜	4.89	6.99	5.91	8.01
½	6.50	8.03	7.95	9.48
¾	7.99	10.06	9.95	12.02
1	11.82	14.38	14.71	17.77
1¼	15.99	20.13	19.90	24.04
1½	19.19	24.06	23.79	28.74
2	25.72	20.13	32.01	38.67
2½	40.66	51.19	.....	.....
3	53.17	66.94	.....	.....
3½	67.62	84.18	.....	.....
4	80.12	99.74	.....	.....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$29 42	$36 08	$35 71	$42 37
2½	44 17	54 70	54 11	64 64
3	57 76	71 53	70 76	84 53
3½	69 46	86 02	85 10	101 66
4	82 30	101 92	100 83	120 45
4½	95 89	1 20	1 30	1 54
5	1 12	1 40	1 52	1 80
6	1 45	1 81	1 97	2 33
7	1 89	2 37	2 53	3 01
8L	1 99	2 49	2 66	3 16
8	2 29	2 87	3 07	3 64
9	2 74	3 43	3 67	4 36
10L	2 54	3 18	3 41	4 05
10	3 28	4 10	4 39	5 21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.
4½-in. and larger, 40%.
4-in. and under, running thread, 20%.
Standard couplings, 4-in. and under, 20%.
4½-in. and larger net.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 87½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $6.50

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double.	30-15%
Standard	15 to 40%
Cpt leather lacing, No. 1	2 00
Leather in side	1.80

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	— 5
Machine, bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 25
Solder, guaranteed	27
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb.	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl.	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$31 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	33 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	37 00	42 00
Copper sheet, planished, 16-oz. base	42 00	48 00
Braziers', in sheets, 6 x 4 base	35 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	17	Atlas	19
Peerless	22	X Empire	14
XX Grand	16	Ideal	18
Superior	21½	X Press	13
X L C R	15		

Colored

Lion	12½	Popular	10
Standard	11	Keen	9
No. 1	14	Fancy	14

Wool Packing

Arrow	30	Anvil	20
Axle	25		

Washed Wipers

Select white.	20
Dark colored.	13
Mixed colored	14

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb.	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

Gross

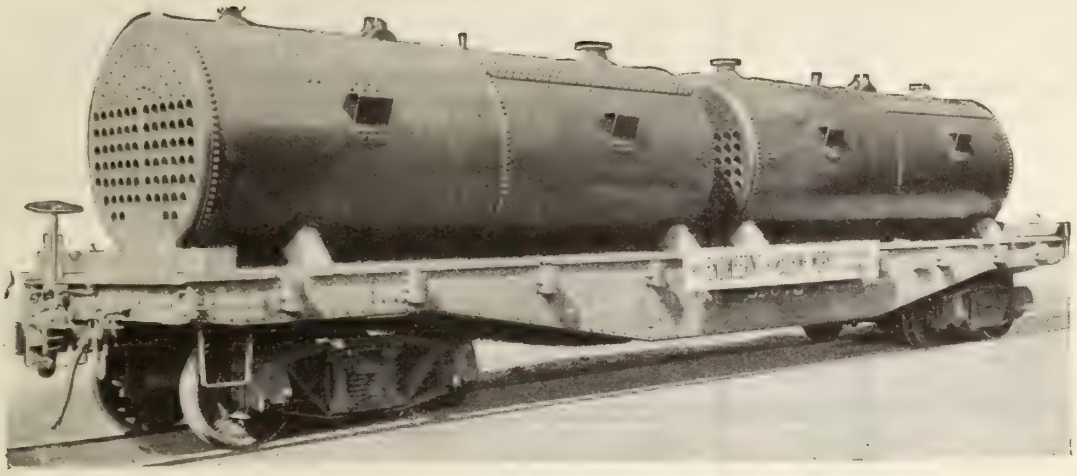
METALS	Mont.	Toronto
Tin	34 00	$39 00
Spelter	7 25	7 50
Lead	6 50	7 50
Antimony	7 25	8 25
Aluminum	28 00	30 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.



Boilers for 1922

Many a manufacturer could pay a dividend out of his coal pile if he went the right way about it. We mean that the very heart of his power plant—his Boilers—are inefficient, out of date, always longing for the repair man—and cost far more than they should in coal expense and labor.

Of course, because his Boilers are away down in the farther end of his plant, and he therefore rarely sees them, he doesn't know what fuel robbers and steam wasters they really are.

Our suggestion is—look into your Boiler situation now. You can get from us new, modern, absolutely efficient Boilers at exceptionally low cost that will be a delight to your staff and prove a very decisive factor in reducing your operating costs.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

Requires Very Little Attention

The Long
Patent
Steam Trap

The Long Trap may be applied to drain steam mains, jacket kettles and separators, and can also be used in drying room systems.

Write for further explana-

J. T. Long
84 Adam St.
MONTREAL, CAN.

CLASSIFIED ADVERTISEMENT SECTION

TWO CENTS A WORD, including the "Power House" box numbers; minimum charge is $1.00 per insertion, for 50 words or less, set in 6 pt. type. Each figure counts as a word. Display ads., or ads. set in border, are at the card rates.

SITUATIONS WANTED—MALE

ENGINEER—HOLDING ONTARIO CERTIFICATE, thoroughly experienced in refrigeration and electricity is open for position. Box 17821 Power House, Toronto. P. 4. H.

STATIONARY ENGINEER, SECOND-CLASS, requires position. 10 years experience with steam, motors and generators, refrigeration, ammonia and carbonic acid systems, heating systems and hydraulic first-class references. Apply Box 5122, Power House.

WANTED—SITUATION AS GAS ENGINEER for producer or city gas, gasoline or kerosene engine. Preferably for small electric light plant, able to do own repairs, climb poles and do own wiring and take full charge. Apply Box 31821, Power House. p.2.h.

INSTRUCTION BY CORRESPONDENCE FOR First and Second Class Certificates, any province, stationary or marine. Terms and particulars on application. Box 13921, Power House. Ph2

EXPERIENCED MACHINIST WITH ENGINeer's certificate, good at general repair work desires position. Apply Box 14921 Power House, P2H

SITUATIONS WANTED.

STATIONARY ENGINEER DESIRES POSITION as engineer or fireman. Holds second class certificate, 20 years experience. Apply to Box 151121, Power House.

ENGINEER DESIRES POSITION IN POWER plant, experienced with oil burners, holding 3rd class papers. Box 24921 Power House. p.h.

EQUIPMENT

WE BUY IDLE EQUIPMENT OR MACHinery; call or write, mentioning Power House. H. W. Petrie, Ltd. Toronto.

MACHINERY FOR RENTAL — WE WILL rent by the month motors, hoists or contractors' plant of any description. Apply, mentioning Power House, H. W. Petrie, Limited, Toronto.

ELECTRIC MOTORS—NEW AND SECONDhand; electric machinery repaired; we also buy motors. Apply, mentioning Power House, The Electrical Engineering Co., 122 Wellington West, Toronto.

WHEN answering advertisements, kindly mention having seen them in this paper.

An Automatic Switch That Turns Lights Off Or On As Desired

A Number of Montreal Grocers Have Apparatus That Gives Them the Benefit of a Well-Lighted Store During the Hours of the Night When People Are on The Streets

MONTREAL.—A number of grocers and other merchants in this city have an apparatus in their store by which the light in either their windows or in the store itself may be turned off automatically during any hour of the night. This enables the grocer to leave his store at six o'clock with all the lights on and in this way getting full benefit of the display during the night when many people are on the street. He does not need to return to his store to turn off these lights so as not to be wasting electric power but this small apparatus will do the work for him at whatever hour he wishes.

Some of the merchants have had this apparatus made to order by local electricians. Others with a mechanical turn made it themselves. It consists of a small tin or galvanized iron box which stands about eight inches in height. An alarm clock is set in the box so that the face can be seen through a round opening in the front. The legs of the clock are firmly secured to the bottom of the box so that there is no chance for the clock to jump or move around when the alarm goes off. On the inside at the top of the box is placed a small switch to which the incoming and outgoing lines are attached as usual in an ordinary open switch. To the handle of the switch is attached a strong cord or in some cases a small metal rod which runs down to an extended arm which is attached to the winding key of the alarm. Then the alarm is set to go off at whatever time the merchant desires, usually 11 o'clock.

Works Accurately

When the alarm goes off the key that winds the spring begins to turn in the reverse direction. In doing this it brings the extended arm downwards which in turn pulls down the string or lever attached to the handle of the switch. In this operation the switch is released and the circuit broken.

As the little attached arm on the alarm key strikes the key on the main spring before it makes half a turn the spring on the alarm never gets a chance to become unwound. As a consequence the merchant never needs to re-wind the alarm. The next evening when he wishes to put in the switch for the lights in his store he gives the alarm key half a turn upwards an' puts the switch in. The clock is once again ready to release the switch when the desired hour comes.

Merchants who have the apparatus in their store claim that it is quite inexpensive to make and a number of them have made quite satisfactory clock-switches themselves. Nothing needs to be said with regard to the advantage of such a switch for every merchant will realize the advertising value of having his store lighted during the night even though he has his store locked up.

In making this apparatus one precaution should be taken and that is that the inlet or the incoming current should come from the top of the box so that when the switch is pulled out there is no danger of a short circuit being caused by the arms of the switch coming in contact with the metal of the clock. When the current enters from the top of the box the arms of the switch are quite "dead" when the switch is pulled out.

$50 Worth of Books for $3

Fifteen of the Best Sellers of the Year For $3 if you subscribe to MacLean's Magazine

During 1921 MACLEAN'S, Canada's National Magazine, has published the whole or major portion of the following fifteen books, which have since been published in book form—or are shortly to be published:

(1) Reminiscences of a Raconteur
—Col. George H. Ham
The recollections of Canada's premier story teller, the C.P.R.'s knight of wit and wisdom, who has known every person worth knowing in Canada during the past half century.

(2) Masques of Ottawa—"Domino"
A series of brilliant, biographical sketches of Canadians prominent in politics and business; analogous to "The Mirrors of Downing Street."

(3) Canada at the Cross-Roads
—Agnes C. Laut
A series of vigorous, inspirational articles showing how Canada is standing on the threshold of nationhood; constructive criticism indicating how full national status is being achieved.

(4) Policing the Plains
—Rev. R. G. MacBeth
The latest and most authoritative history of the Royal North West Mounted Police, by a padre who himself took part in the Riel Rebellion and has associated with many of the leading characters in Canada's famous frontier force.

(5) The Drama of Our Great Forests
—Arthur Heming
The pulsating, throbbing, human-interest story of Canada's great northern fastnesses, told by the man who will go five hundred miles to get a fact; authentic, enthralling.

(6) The City of Peril—Arthur Stringer
An up-to-date narrative of a Bolshevistic plot which was nipped in the bud by an adventurous young millionaire; including a delightful Stringer-like romance.

(7) Pawned—Frank Packard
A fast-moving story of a triple regeneration, shifting wth kaleidoscopic speed from the South Sea Islands to this continent—novel, intense, gripping, mystifying.

(8) The Valley of Gold—David Howarth
The first novel from the pen of an athletic Methodist parson now resident in Miami, Manitoba—a true-to-life account of the Qu'Appelle Valley of Saskatchewan as it was twenty years ago; vigorously, thoroughly Canadian.

(9) Mostly Sally
—Pelham Grenville Wodehouse
A worthy successor to "The Little Warrior," told in the inimitably facetious and whimsical vein of this English master-craftsman.

(10) The Yellow Streak
—Valentine Williams
The story of a murder mystery solved by real human beings; from the pen of the author who wrote "The Man With the Club Foot."

(11) The Gates of Tien T'ze
—Leslie Howard Gordon
An enthralling book which ran in MACLEAN'S as a five-part serial; dealing with life in London when Anglo-Saxons and Chinese met at cross purposes.

(12) Lenix Ballister, Diplomat
—Archie McKishnie
A dozen short stories about the typical Canadian negro of Western Ontario; a forthcoming volume from the pen of one of Canada's foremost fiction writers.

(13) Prince Renine—Maurice Le Blanc
Eight more stories in which the leading character is the thinly disguised Arsene Lupin, one of the world's famous characters in detective fiction.

(14) A Series of Short Stories
—"Sapper"—H. C. McNeile
Ten or a dozen brilliantly written stories, impregnated with human interest, from the pen of one of the most successful English authors brought to the fore during the war.

(15) The Man Who Knew Too Much
—G. K. Chesterton
A collection of eight stories, each with its distinctive mystery, and containing the usual Chestertonian twist, from the pen of the man who wrote the "Father Brown" series.

Readers of MACLEAN'S got all these books in 1921—ten books of fiction and five of a more serious character, biographical, reminiscent, political—permanent literature.

In addition, they got a most attractive offering of the best short stories and the twice-a-month Review of Reviews department, which kept them posted on current topics and developments in all parts of the world, as well as the multitude of Special Articles on Topics of National Interest in Canada, which have made MACLEAN'S something more than a magazine—a National Institution.

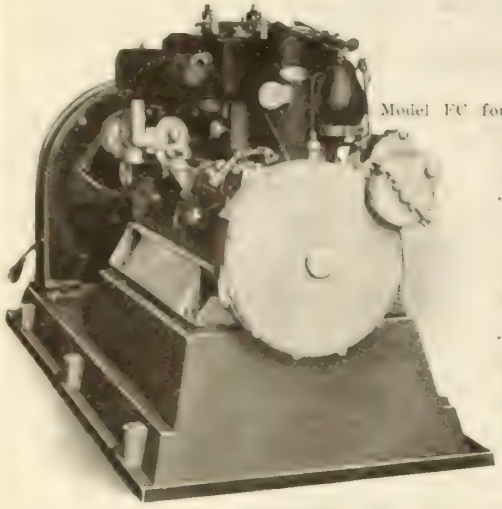
MACLEAN'S readers got all this immense value in 1921—in 1922 they will get bigger value still. And you get all this for $3.00—the price of a year's subscription—24 twice-a-month issues of

MACLEAN'S
"CANADA'S NATIONAL MAGAZINE"

The MacLean Publishing Co., Limited, 143-153 University Avenue - Toronto

When Power is Off a

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float



Model FC four cylinder, 60 H. P. STERLING, operating on illuminating gas, driving a 30 K.W., 80% P. F., 1,200 A.R. P.M., 240 V., 3 phase, 60 Cycle, General Electric Generator. A neat, compact power plant for emergency in residence, manufacturing plant or town.

Catalogue and recommendation on request.

STERLING ENGINE CO.
DEPT. C BUFFALO, N.Y.
High duty gas and gasoline engines, 12 to 300 H.P

Saves When You Use

Time is a big item of cost in testing gauges. With an American Dead-Weight Gauge Tester you can test three or four gauges in the time ordinarily required to test one with most other instruments. This is partly because you can hold the pressure at any point as long as desired, thus making it quick and easy to take accurate comparisons of the gauge reading at any point on the dial with an

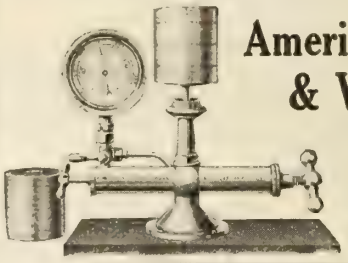
AMERICAN DEAD WEIGHT GAUGE TESTER

Another time-saving feature is in the fact that the American is the only completely self-contained tester on the market.

In addition to saving minutes and therefore saving money every time it is used, the American also saves money in the long run, for its rugged construction means long life. It is lighter, less bulky and therefore handier to carry around than most testers.

Made in various sizes for pressures from 5 lbs. up to 1000 lbs. Other equally efficient types for higher pressures.

Our interesting Gauge Tester Circular sent on request.



American Steam Gauge & Valve Mfg. Co.

Boston, Mass.

Atlanta New York
Los Angeles
Chicago Pittsburgh

Free Tool Grinding Chart

Grind your cutting tools in exactly the right way to get best results—and you save time. That's obvious. It is precisely that that this Tool Grinding Chart enables you to do.

It has been adopted as standard by many firms that found it a long way better than guess work.

CANADIAN MACHINERY would like to see this Chart in every shop in the Dominion. Mail the coupon below for your copy to-day.

Shows at a glance Correct Clearance and Rake Angles for Cutting Tools

CANADIAN MACHINERY,
153 University Avenue, Toronto.

Please send me / us free, one of your tool grinding charts.

Signed .....

Firm Name .....

St. Address .....

City .....

Prov. .....

Everyone Must "Dig in" For 1922 Prosperity!

Optimistic and determined co-operation is the 1922 need; for only by everyone working together and working hard, can a big year be realized.

"Columbia" Thermometer.

We can now Supply Instruments

to our Canadian customers from our **Toronto office.** We have on hand a complete stock of standard instruments and are ready to give every co-operation. Write us at once.

THE Schaeffer & Budenberg MFG. CO.

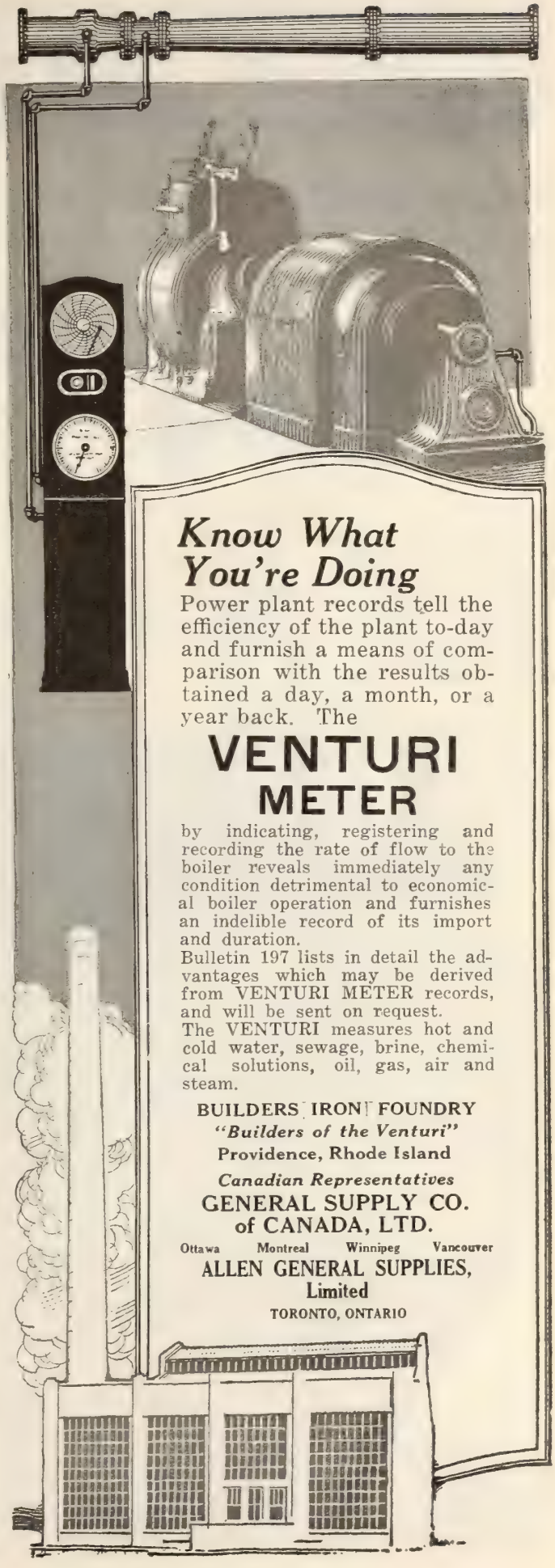
Brooklyn, N.Y.

Makers of Columbia Recording Thermometers and Gauges with

TIME PUNCH

67-69 Frederick St., TORONTO

Phone Main 2578



Know What You're Doing

Power plant records tell the efficiency of the plant to-day and furnish a means of comparison with the results obtained a day, a month, or a year back. The

VENTURI METER

by indicating, registering and recording the rate of flow to the boiler reveals immediately any condition detrimental to economical boiler operation and furnishes an indelible record of its import and duration.

Bulletin 197 lists in detail the advantages which may be derived from VENTURI METER records, and will be sent on request.

The VENTURI measures hot and cold water, sewage, brine, chemical solutions, oil, gas, air and steam.

BUILDERS IRON FOUNDRY

"Builders of the Venturi"

Providence, Rhode Island

Canadian Representatives

GENERAL SUPPLY CO. of CANADA, LTD.

Ottawa Montreal Winnipeg Vancouver

ALLEN GENERAL SUPPLIES, Limited

TORONTO, ONTARIO

STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN

All parts made to gauge and interchangeable. Give us opportunity to figure on your pumping requirements.

Fig. 7242

STEAM DRIVEN OUTSIDE PACKED PLUNGER PUMPS

A full line of patterns in belted or direct connected power pumps.

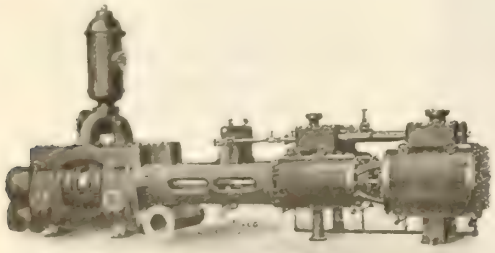


Fig. 7581

WATER WORKS PUMPING ENGINE

Full Line of Water End Patterns Up to and Including Capacity of 5,000,000 U.S. Gallons Per 24 Hours.

Established 1852.

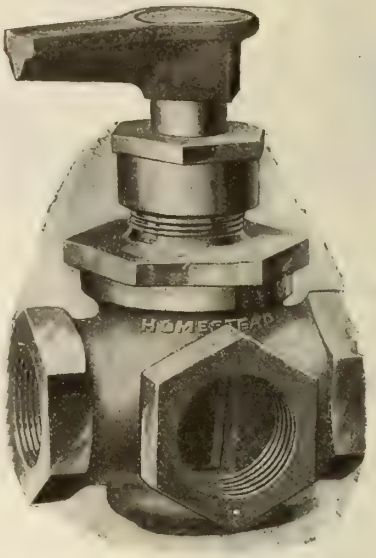
THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

HOMESTEAD Quarter-Turn Valves

Built in

Straight-way
Three-way and
Four-way
Patterns

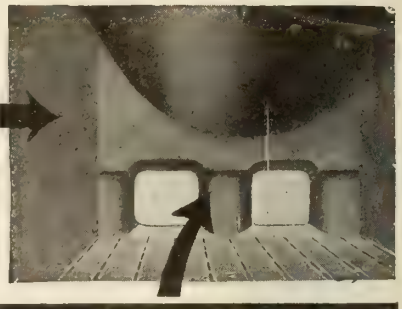
for the most severe classes of service. Absence of seats eliminates scoring and cutting and insures longevity. Built of brass, semi-steel, bronze and special bodies. Patented cam adjustment maintains absolute accuracy. And best of all they operate by a time-saving quarter turn. Ask for the details.



Homestead Valve Mfg. Company
HOMESTEAD, PA.

A FURNACE WALL LINING that is free from joints, cracks, falling bricks and mortar.

Any workman can make this furnace lining.



Perfect Monolithic Boiler Arches

properly flared for easy firing, durably made with the genuine

BETSON'S

REG. U.S. TRADE MARK PAT. OFF. PLASTIC FIRE BRICK

Here is a splendid repair material for your present boiler furnace linings, as well as the proper thing to use for front and back arches and gas-tight baffles. Used by thousands of plants with continued satisfaction.

Write for booklet that tells of its usefulness in the boiler room.

Betson Plastic Fire Brick Co., Inc.
P. O. Box 386-6, Rome, N. Y., U. S. A.
Canadian Distributors: INTERNATIONAL CHEMICAL CO.
44-6 Lombard Street, Toronto, Ont., Canada

Tycos
temperature instruments

INDICATING

Show what you want to know about temperature in your processes.

RECORDING

Write the temperature records you need to have in your processes.

CONTROLLING

Give the control you desire over temperature in your processes.

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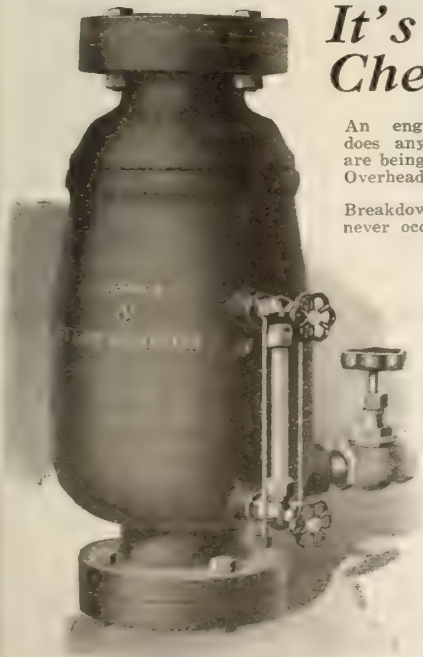

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Breakdowns of this nature need never occur. They can be prevented by supplying quality steam — steam that is hot and dry.

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If Your Fireman

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Possibly his first move would be the installing of

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Because being a practical man he would want to take every precaution to safeguard his plant against the coal wastes that are bound to occur where no checking system is employed. He knows that dirty flues, dirty grates, etc., mean wasted coal. Bailey Meters show when these things happen.

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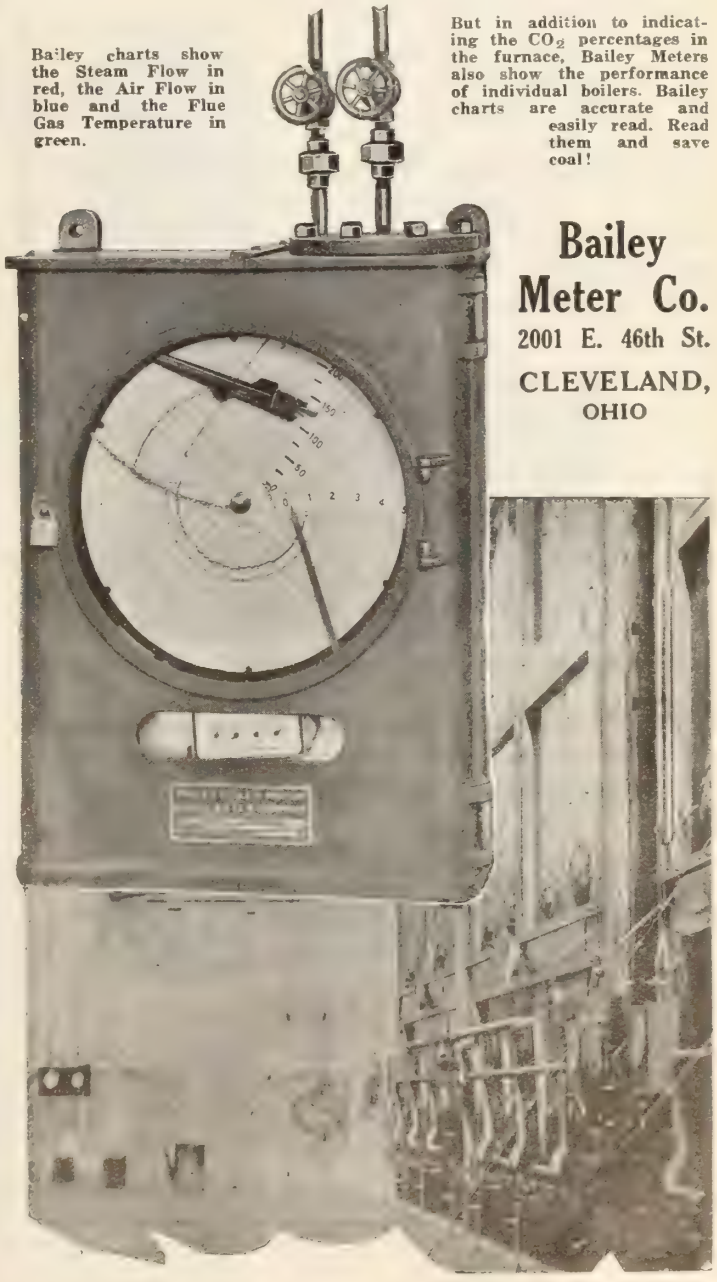

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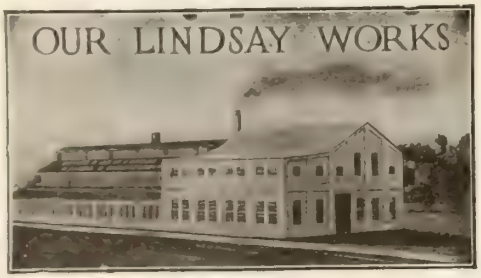

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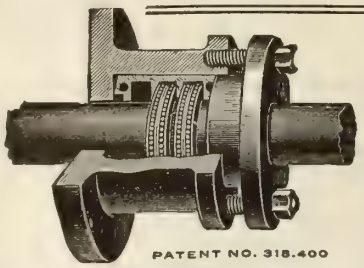

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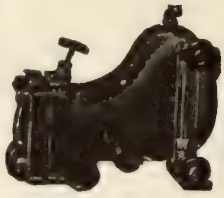

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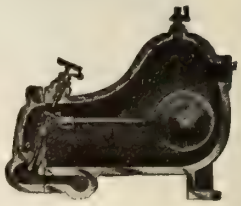

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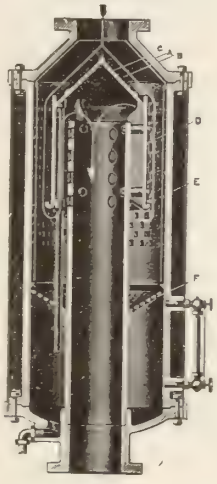

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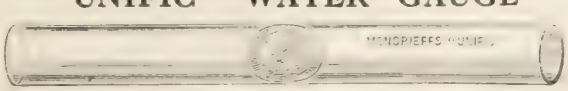

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Protects coal from the ravages of Pick and Shovel

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Every square foot of storage space is covered with a minimum of movements and time. Capacity from 60 to 90 tons per hour. Write or wire for particulars.

LAKESIDE BRIDGE & STEEL COMPANY, 159 Villard Ave., NORTH MILWAUKEE, Wis.

New Truths and Old Fallacies

Atomic Volume, etc.--*Continued*

Despite the fact that impurities of low atomic volume are injurious to a babbitt alloy, some manufacturers seem quite oblivious of it, as they give wide publicity to the fact that their alloys contain such impurities, even incorporating them in the name of their products as an attractive feature to secure confidence and business.

If, in the future, such compositions are not featured so prominently, it can be judged from whence comes the reformation.

The presence of oxide in an alloy is equally harmful, as it cannot be reduced to a metallic state by the ordinary process of compounding in an open kettle, and, therefore, its exclusion is important.

GRIT AND DUST

A valuable feature of Magnolia Metal, not previously mentioned in this article, is its immunity from the generally harmful effects of grit and dust. Under such conditions, Genuine Babbitt and bronze and brass bearings heat and wear rapidly and are prone to score and seize, but in the case of Magnolia, these fine particles of grit become embedded in the matrix and covered over by it, so that harmful effects are neutralized. Because of this noticeable Magnolia feature, it is used extensively in cement, plaster, sand drying, grinding, buffing, rock crushing and other similar machinery bearings. This desirable feature has also been commented upon by steamship engineers in relation to propeller shaft bearings which are subjected to ashes in the bilge water.

(Continued next month)

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"New Truths and Old Fallacies"
Address our Montreal Office

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By Inefficient Handling Methods

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HEPBURN Hand Overhead Crane

Built with Single or Double 1-Beams, in sizes from ¼ to 20-ton capacity.
We also make Pumps, Vertical Engines, Compressors, Castings and Forgings.

John T. Hepburn Limited
Engineers and Iron Founders
18-60 Van Horne St., TORONTO

CHIMNEYS
Arthur S. Leitch Co., Limited, Toronto.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N.Y.

CLEANERS, BOILER TUBE CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.
Babcock & Wilcox Ltd. Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Pidgeon Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

CLOSETS
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd. Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co. Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CARBONIC ACID GAS
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal
MacGovern & Co., Inc., Montreal Que.
The John H. McGowan & Co., Cincinnati.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co. Ltd., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd. Montreal.
MacGovern & Co., Inc., Montreal Que.
Babcock & Wilcox Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto
Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md

DRAFT GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Company, Ltd., Windsor, Ont.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Jenckes Machine Co., Inc., Montreal Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can., Ltd. Toronto

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co. Ltd., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
B. F. Sturtevant Co., Boston Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, STEAM
Canadian Sirocco Company, Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Canadian Sirocco Company, Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N.Y.
Jas Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Canadian Sirocco Company, Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Sturtevant Co., B. F., Toronto, Can

FAN ENGINE REGULATORS
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd. Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd. Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.
C. B. Turner, Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.
C. B. Turner, Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Miss.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

An Expensive Tool

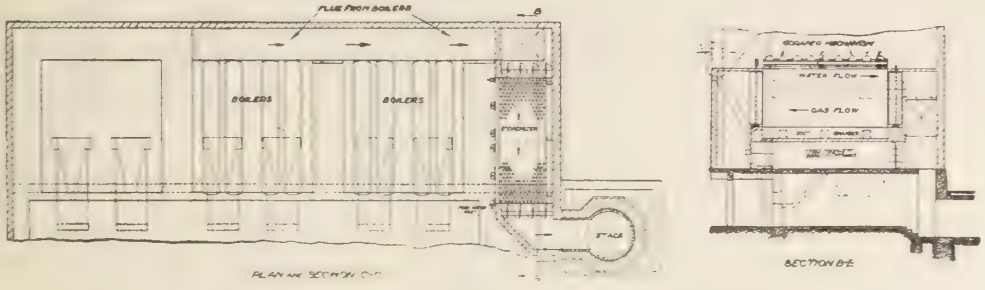
Every shovel of coal costs money { at the mine / at your plant / on your grates

Every shovel of ash costs money to remove.

Sturtevant Fuel Economizers, by heating the boiler feed water, utilize the heat which is wasted up the stack.

Every 10 degrees rise in feed water temperature means 1 per cent less { coal to shovel / ash to remove / freight to pay

What does this mean on your coal bill?



A Typical Sturtevant Fuel Economizer Layout

B. F. STURTEVANT COMPANY of CANADA, Ltd.
TORONTO GALT MONTREAL

Sturtevant

FLOOR AND CEILING PLATES
Crane's Limited, Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co. Ltd., Toronto.

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co.
Dominion Flow Meter Co., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

FLUE CLEANERS
Shell Bar Boiler Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Bowing Hydraulic & Eng. Co. Ltd., Lindsay
Manitanou Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

FURNACES
Under-feed Stoker Co of Canada, Ltd Toronto, Ont.

FURNACE LINING
Bolson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Johnston Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Bolson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Johnston Fire Brick Co., Chicago, Ill.

FUSES
Canadian Johns-Manville Co. Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Belgian Asbestos (Canada) Co., Toronto.
Shell Bar Boiler Supply, Ltd., Toronto.
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Steam Boiler Equip. Co., Toronto.
Durotia Mfg. Co., New York, N.Y.
Frick Co. Waynesboro Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boiler Supply Co., Toronto.
Sarco Co. Inc., New York, N.Y.

GAS ANALYZERS CO-2
Dominion Flow Meter Co., Toronto.

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal
Laurie & Lamb, Montreal.

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

GAUGE COCKS, STANDARD AND EXTRA HEAVY
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor Ont.

GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
John Moncrieff. Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Bowing Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTORS
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
Waterous Engine Works Co., Brantford.
Mason Regulator & Eng. Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal
Gelinas & Pennock, Reg'd, Montreal.
Canadian Steam Boiler & Equipment Co., Toronto.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boiler Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boiler Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd. Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. B. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boiler Supply, Ltd., Toronto.
W. B. Sexton Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boiler Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. B. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Company, Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Bowing Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

ICE MAKING MACHINERY
Bowing Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
York Mfg Co. York, Pa

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Johns-Manville Co. Ltd., Toronto.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal. Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Canadian Johns-Manville Co. Ltd., Toronto.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

LACE LEATHERS
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.

LIGHTING FIXTURES, STREET
Northern Electric Co., Ltd., Montreal.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Darling Bros., Ltd., Montreal, Que.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Montreal

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Maclean Underfeed Stoker Co., Toronto,
Sanford Riley Stoker Co., Worcester, Mass.
Maclean Underfeed Stoker Co., Toronto, Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

METERS
The Bailey Meter Co., Cleveland.
Dominion Flow Meter Co., Toronto.
Can. H. W. Johns-Manville Co., Toronto

METERS (OIL, KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

METER TESTERS
Mueller Mfg. Co., H., Sarnia, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OILS
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, LUBRICATING
Kellogg & Co., E. H., New York, N.Y.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

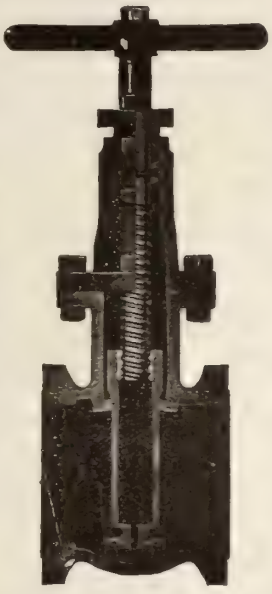
OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
The Mason Regulator & Eng. Co., Ltd., Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

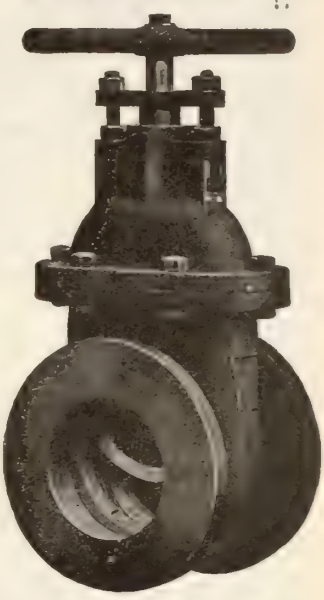
KERR

("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

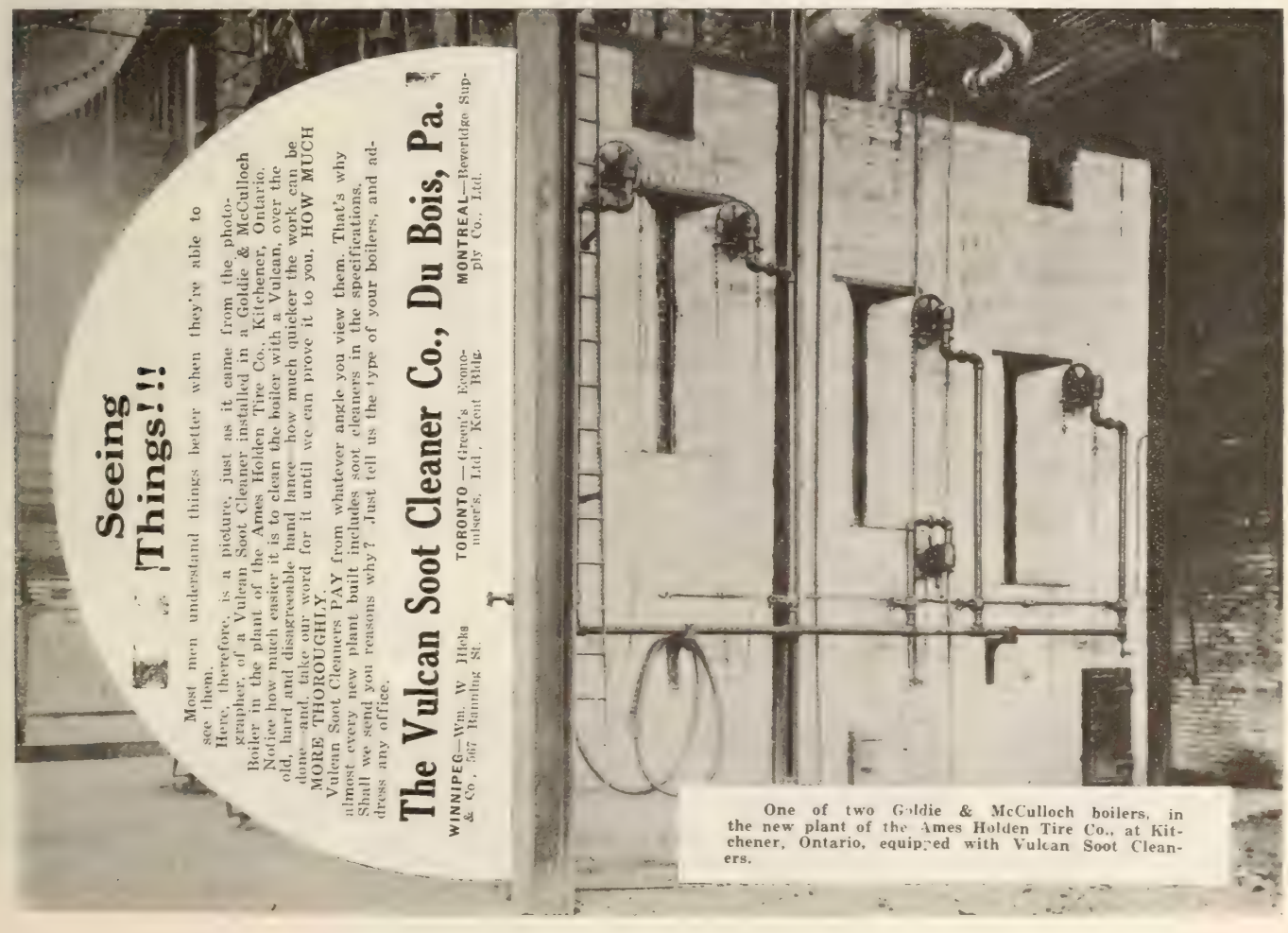


If you have been using them, we are confident that our satisfaction will bring us your repeat orders These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.



When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**



Seeing Things!!!

Most men understand things better when they've able to see them.

Here, therefore, is a picture, just as it came from the photographer, of a Vulcan Soot Cleaner installed in a Goldie & McCulloch Boiler in the plant of the Ames Holden Tire Co., Kitchener, Ontario.

Notice how much easier it is to clean the boiler with a Vulcan, over the old, hard and disagreeable hand lance—how much quicker the work can be done—and take our word for it until we can prove it to you, HOW MUCH MORE THOROUGHLY.

Vulcan Soot Cleaners PAY from whatever angle you view them. That's why almost every new plant built includes soot cleaners in the specifications. Shall we send you reasons why? Just tell us the type of your boilers, and address any office.

The Vulcan Soot Cleaner Co., Du Bois, Pa.

WINNIPEG—Wm. W Hicks & Co., 567 Banning St.

TORONTO — Greey's Economisers, Ltd., Kent Bldg.

MONTREAL—Beveridge Supply Co., Ltd.

One of two Goldie & McCulloch boilers, in the new plant of the Ames Holden Tire Co., at Kitchener, Ontario, equipped with Vulcan Soot Cleaners.

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.
OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Supply Co., Montreal.
W. J. Brown (Tucks), Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
[illegible] Montreal
[illegible] Co. Windsor, Ont.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Hoffman Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.
PACKING, METALLIC
Crane Packing Co., Chicago, Ill.
[illegible] Co. Windsor, Ont.
S. F. Bowser Co., Ltd., Toronto, Ont.
PACKING, OIL
Crane Packing Co., Chicago, Ill.
[illegible] Co. Windsor, Ont.
PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.
PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
[illegible] Mfg. Co., York, Pa.
PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.
PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.
PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.
PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.
PIPES, WATER
[illegible] & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.
PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.
PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.
PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ort.
PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.
Lunkenheimer Co., Cincinnati, Ohio.
PLUMBING SUPPLIES
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.
POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co., Brantford.
POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay
PRESSURE REGULATORS
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
[illegible] Toronto, Ont.
PRESSURE AND VACUUM RELIEF VALVES
[illegible] Ltd.
[illegible]
PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay
Frick Co., Waynesboro, Franklin Co., Pa.
PRESSURE AND REDUCING VALVES
[illegible] Ltd.
[illegible]

PULLEYS
D. K. McLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullough Co., Galt.
Waterous Engine Works Co, Brantford.
PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.
PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.
PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros. Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton
PUMPS, BILGE.
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.
PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford
PUMPS, CIRCULATION.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Pratt & Cady, Hartford, Conn.
PUMPS, GAS
Smart Turner Co., Hamilton, Ont.
PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
S. Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton
[illegible]-Steel Stoker Co. of Canada, Ltd. Toronto, Ont.
PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart Turner Machine Co., Hamilton
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
The John H. McGowan & Co., Cincinnati, Ohio
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co. Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.
PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.
PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Darling Bros. Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.
PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
RADIATORS
Crane's Limited, Montreal.
RADIATOR TRAPS
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.
RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
RADIATOR VALVES
Lunkenheimer Co., Cincinnati, Ohio.
RAGS
Shell Bar Boico Supply, Ltd., Toronto.
RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company Ltd., Toronto.
REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.
RECEIVERS, AIR
MacKinnon Holmes & Co., Sherbrooke.
RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company Ltd., Toronto.
RECORDING INSTRUMENTS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Canadian Johns-Manville Co. Ltd., Toronto.
Dominion Flow Meter Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnal-Waring Co. Philadelphia, Pa.
RECORDEDS CO2
Sarco Company, Inc., New York.
RECORDING THERMOMETER AND GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn N.Y.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Taylor Instrument Co., Toronto, Ont.
REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.
REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.
REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.
REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.
REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.
REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Toronto, Ont.
REGULATING VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.
RETORTS
MacKinnon Steel Co., Sherbrooke, Que.
REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.
RODS, COPPER, BRASS AND BRONZE
H. Mueller Mfg. Co., Ltd., Sarnia.
ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.
RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.
ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd. Montreal.
SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.
SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.
SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.
SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.
SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.
EXPANSION ENGINES
SINGLE, COMPOUND AND TRIPLE
Laurie & Lamb, Montreal.
SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal
SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal
SOOT BLOWERS
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.
SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.
SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.
SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.
STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.

"DART" UNIONS

WILL NOT LEAK

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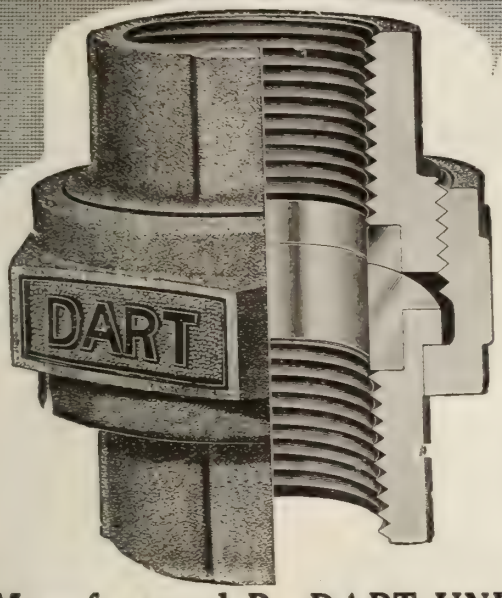

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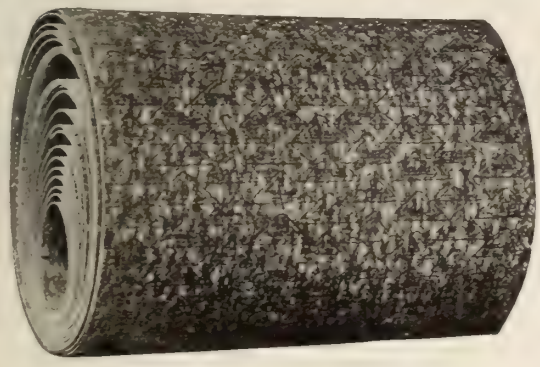

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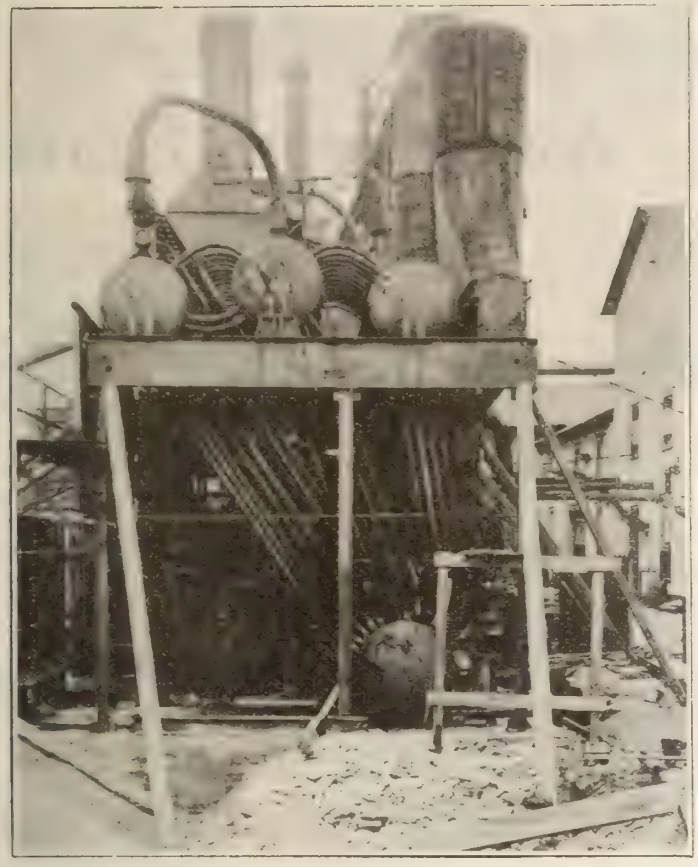

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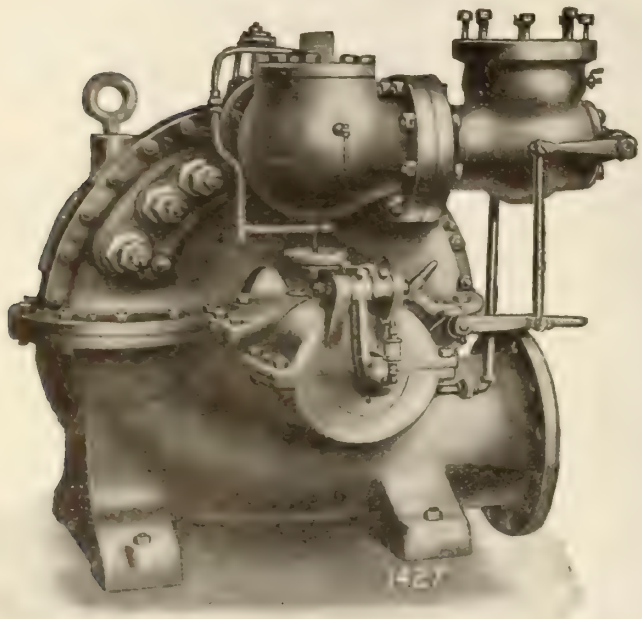

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PERHAPS you smile confidently and say: "Why, I have no belt troubles." If so you are indeed fortunate. Do you know that every day while the busy executive is striving to find a means to keep overhead down, an improperly selected belting is actually piling up overhead? And the worst part of it is that it is sometimes hard to tell the difference between a good belt and a poor one.

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MONTREAL: Southam Building — LONDON, ENG.: 88 Fleet Street, E.C. — WINNIPEG: 901 Confederation Life Building

Vol. XV.—No. 2. Publication Office, Toronto—Jan. 20, 1922 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

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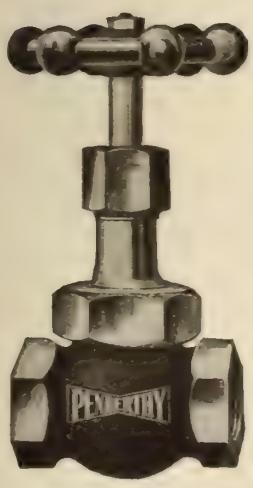

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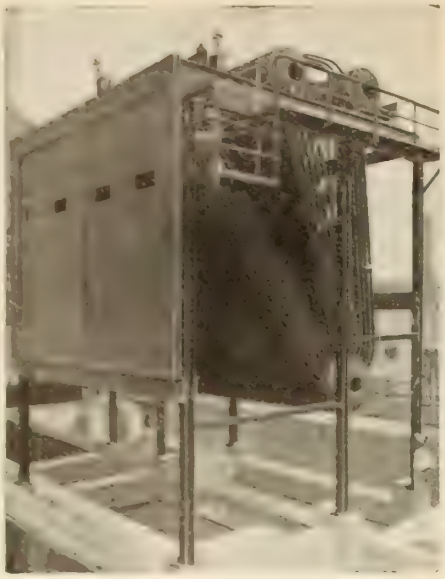

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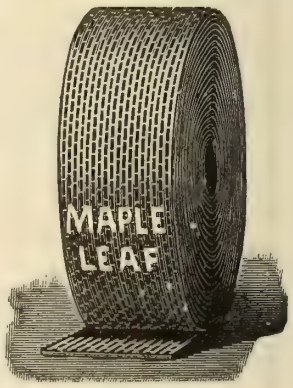

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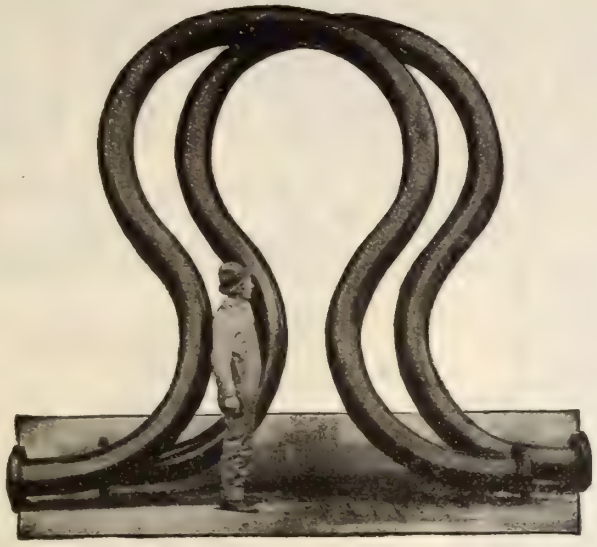

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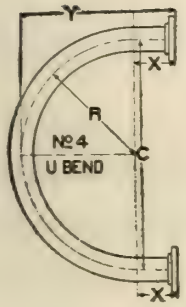

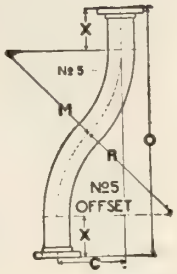

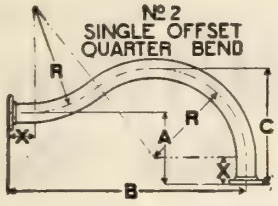

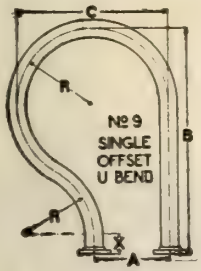

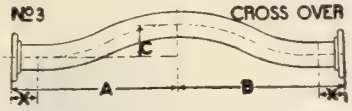

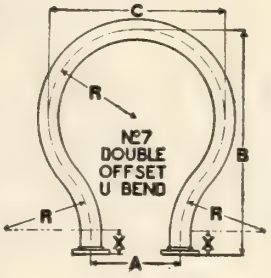

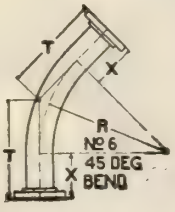

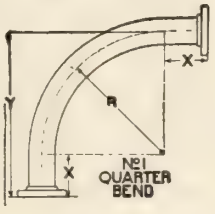

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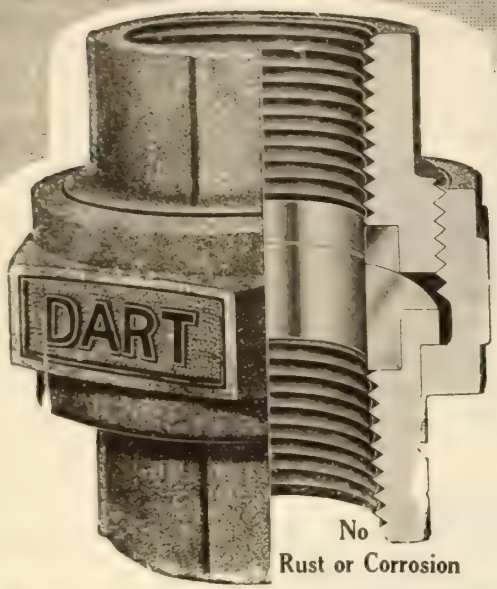

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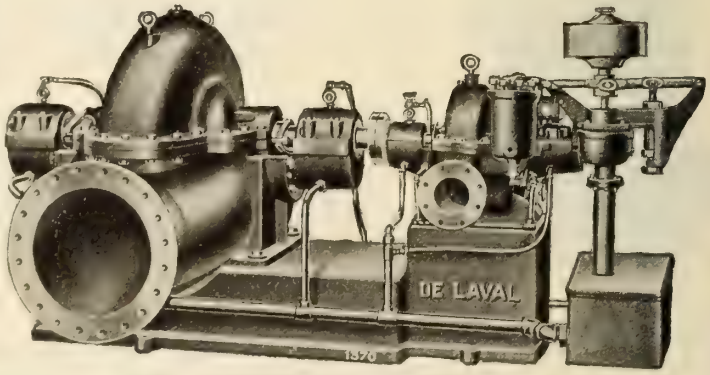

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LUNKENHEIMER
Cast Steel Valves

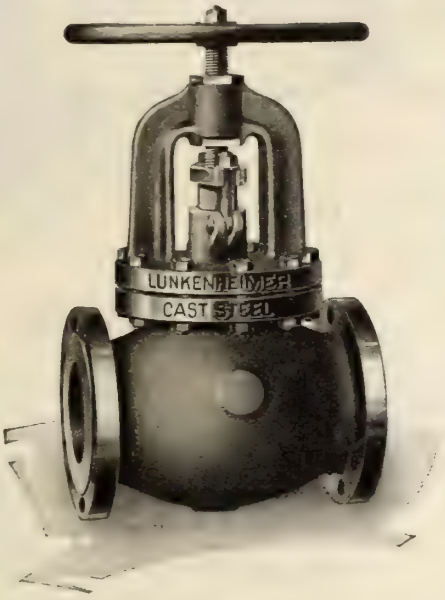

Fig. 606

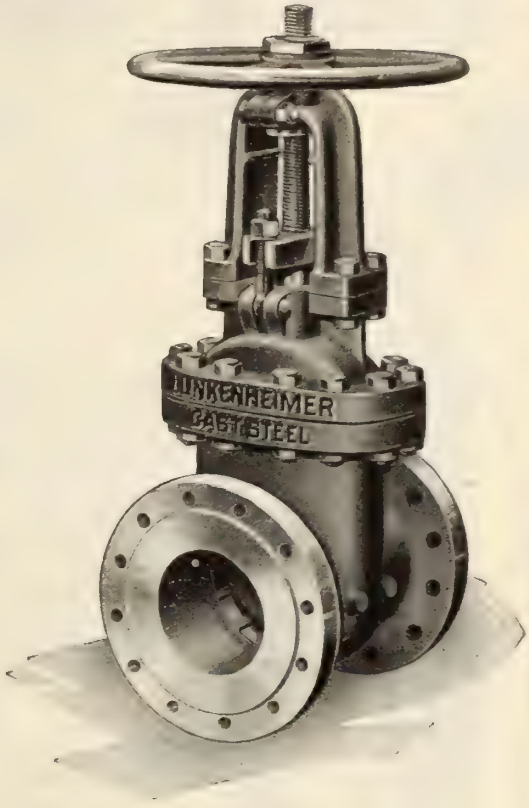

Fig. 1353

For power plants where high pressures and more particularly excessive temperatures prevail. The 800° F. temperature and 350 pounds pressure rating for which LUNKENHEIMER CAST STEEL VALVES are guaranteed covers every requirement of modern practice and provides a margin of safety which insures both efficiency and maintenance economy.

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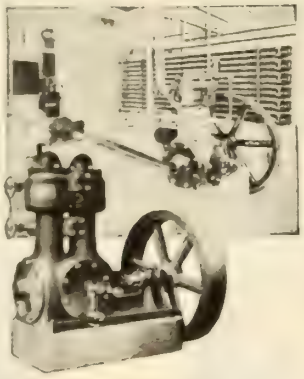

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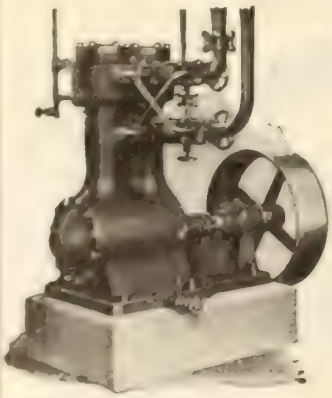

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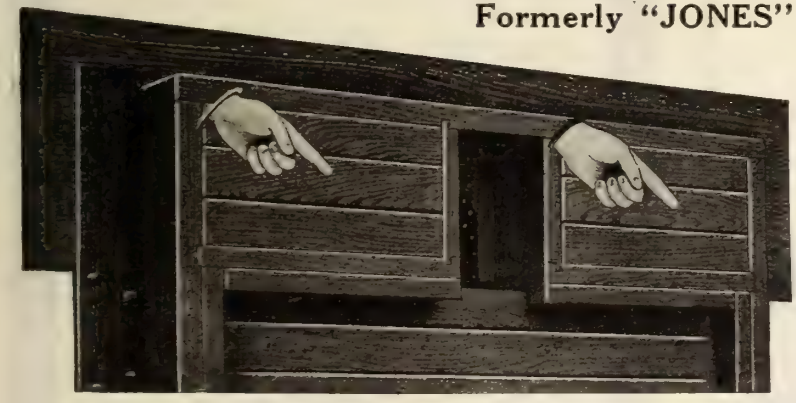
Heavy Duty Cold Storage Doors



Have Many Points of Superior Construction

Note the back of our Standard Track Head Frame with track part; we insulate and finish our track frame heads, an unusual feature. Then note the simplicity of the Track Lift device over the door; no springs or other delicate parts to get out of order. Our Automatic Self-tightening Fastener draws the door rigidly tight each time it is slammed. The hinges too are three to five times heavier than other makes.

These features, and many others, are fully explained in catalog No. 10. Write for it.

JAMISON COLD STORAGE DOOR CO.

Formerly Jones Cold Store Door Co., HAGERSTOWN, MD., U.S.A.

THIS TEXT BOOK—FREE

Cut Ad. and send name, address and position to

FLEXIBLE METALLIC PACKING CO.

WINDSOR CANADA

AGENTS:

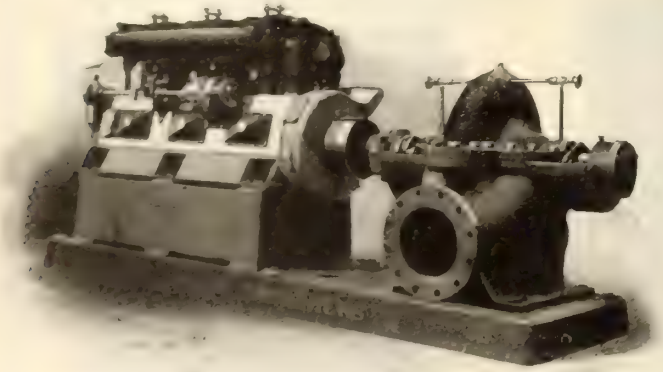
R. C. Miller Oil & Supply Co., Montreal and Vancouver

H. E. CARMAN, 234 Cordova St., Vancouver, B.C.

One Ordinary Fire Costs More than a

Sterling THE ENGINE of REFINEMENT *For the finest boats that float*

and a set like this



STERLING, 125 H.P., 6 cylinder engine, direct connected to Allis-Chalmers 1,200 U.S. Gal. per Min. centrifugal pump, speed 1,200 R.P.M., 260 ft. head, at Public Utilities Commission water works, Napanee, Ont. Operated when power is off.

Catalog and recommendation on request.

STERLING ENGINE CO.

Dept. C Buffalo, N.Y.

High duty gas and gasoline engines, 12 to 300 H.P.

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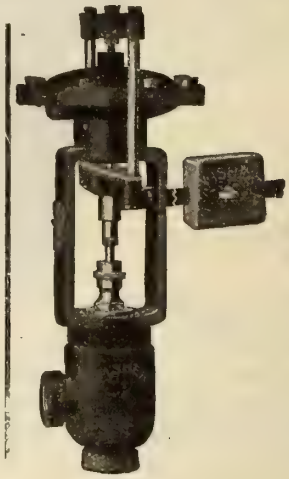


Perfect Control of Vacuum Pumps

If you are using a Steam-Driven Vacuum Pump for any purpose in your plant you will want the

Fisher Vacuum Pump Governor

(Type 8)

It is a thoroughly reliable regulator that will accurately maintain any desired vacuum.

The reliability of this governor has been established by its extensive use. It has been adopted as standard equipment by some of the largest manufacturers of vacuum pumps and installers of heating apparatus in the country.

Its construction is such that all unnecessary friction is eliminated. The large controlling diaphragm makes it extra sensitive. Lever and weight control is positive, and we can furnish this valve in either angle or globe type—a great convenience on many installations.

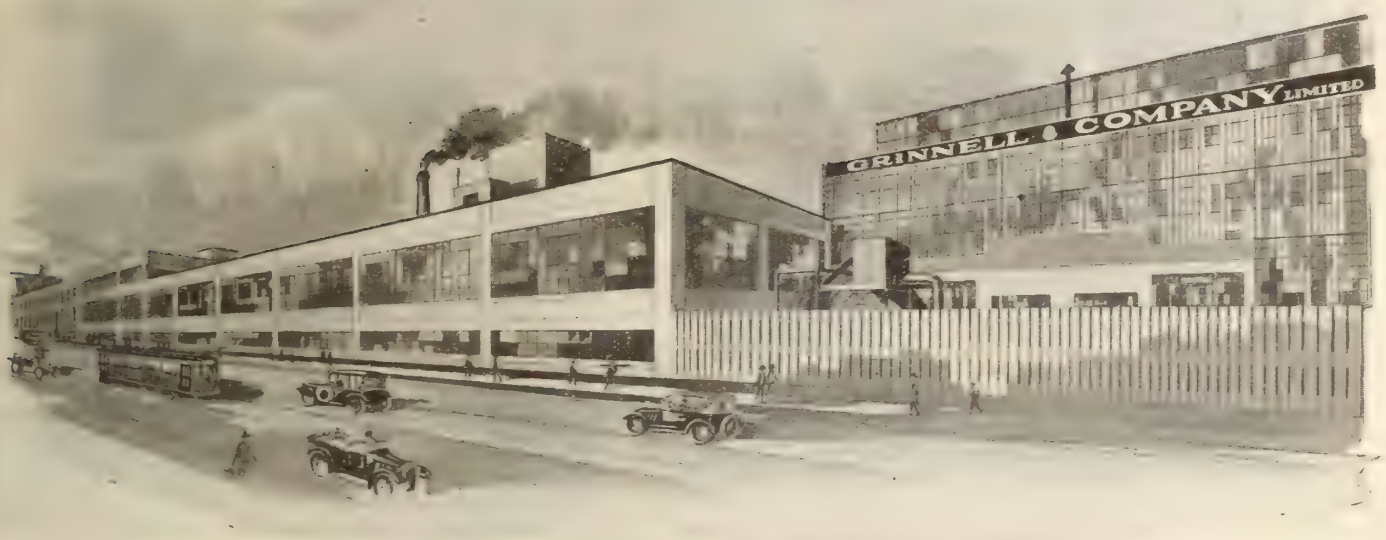
Our book, "POWER PLANT SPECIALTIES," contains valuable information to engineers. Write for your copy to-day. Fisher Power Plant Specialties can be ordered through jobbers anywhere in Canada.

The Fisher Governor Co.

929 Fisher Ave. Marshalltown, Iowa

Agencies in all principal cities

Jenkins Valves



THE GRINNELL COMPANY'S PLANT AT TORONTO, ONTARIO

The Grinnell Plant At Toronto Is Equipped With Jenkins Valves

Fig. 300

Like many other manufacturers with big production and wide distribution the Grinnell people fully appreciate the importance of dependable valve equipment.

Naturally when it was a question of dependability they chose Jenkins —the Valves with the Diamond Trade Mark.

Hence Jenkins Valves, through the efficient and trouble-free service they render, are playing an important part in the production of the well-known Grinnell Sprinkler Systems.

Jenkins Valves are made in types and sizes for every service everywhere. They can be installed with confidence to furnish maximum service and to function satisfactorily under unusual conditions and hard usage.

Write for Catalog No. 8.

Jenkins Bros.

TRADE JENKINS MARK Jenkins Bros

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TRADE JENKINS MARK Jenkins Bros

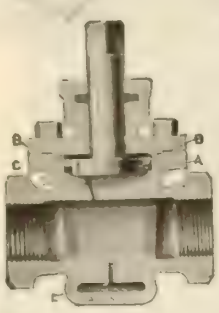
Head Office and Works: 103 St. Remi St. Montreal Can.

TORONTO WINNIPEG VANCOUVER

European Branch 6 Great Queen St. Kingsway. London, W.C.2. Eng.

Agencies in all the principal countries of the world

HOMESTEAD
Quarter-Turn Valves

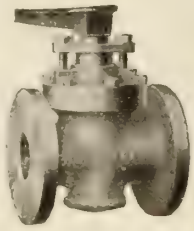


Why they can't be otherwise than tight

They are **seatless!** They are not subject to the cutting and scoring which affects the seating surfaces of globe and gate valves.

Tightness is further insured by a patented wedging cam that automatically forces the plug downward in action and again instantly releases it.

A single quarter-turn operates a Homestead. That's why they are preferred to time-wasting, money-consuming globe and gate types.



May we send you a copy of our latest catalogue?

Homestead Valve Mfg. Company
Homestead, Pa.

STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN

All Made to Gauge. All parts interchangeable. Give us an opportunity to figure on your pumping requirements.

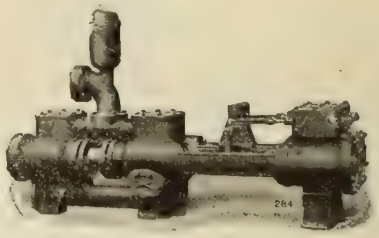


FIG. 7284

We have full line of Patterns for direct acting steam pumps and belted or direct connected power pumps.

Established 1852.

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS
Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1921 catalog showing the Curtis line of Engineering Supplies.

Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY
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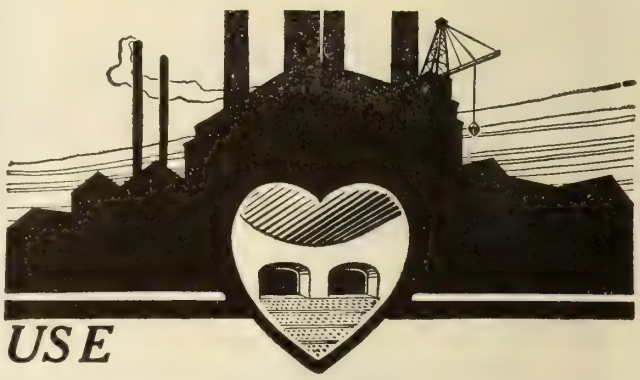


USE

BETSON'S
REG. U.S. PAT. OFF. TRADE MARK
PLASTIC FIRE BRICK

IN THE HEART OF YOUR PLANT

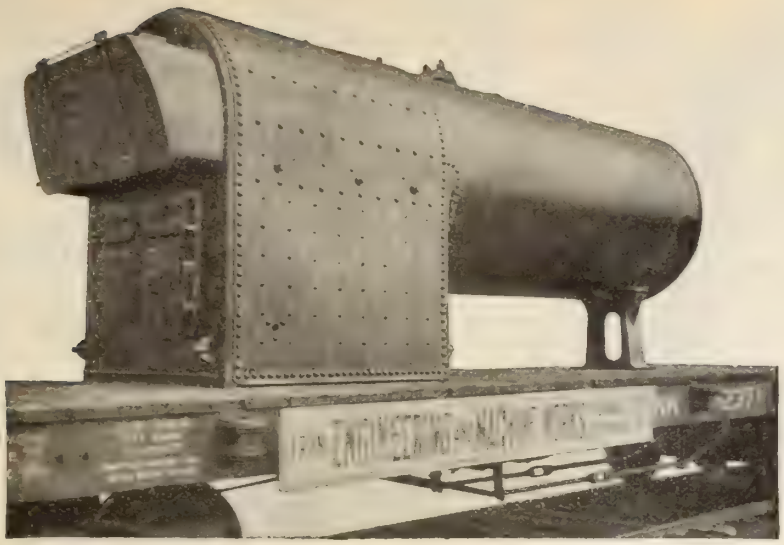
Build permanent, properly flared, one-piece boiler arches and walls without any bricks to fall out. Betson's Plastic Fire Brick eliminates frequent shutdowns for repairs, prevents inleakage of cold air. Any man can build one-piece arches and make perfect furnace linings with Betson's Plastic Fire Brick.

Write for informative booklet for boiler room use

Betson Plastic Fire Brick Co., Inc.
P.O. Box 386-6, Rome, N.Y.

Canadian Distributors: INTERNATIONAL CHEMICAL CO.
44-6 Lombard Street, Toronto, Ont., Canada

If it isn't BETSON'S it isn't Plastic Fire Brick



For Modern, Efficient, Economical Heating—

Put in Keystone Heating Boilers—the most efficient type you can buy to-day. Built in various styles and in all sizes and with smokeless furnace when required. We have been very successful in building this Keystone Boiler due to our long experience and ample facilities in general boiler making. Prices low.

Engineering and Machine Works of Canada, Limited

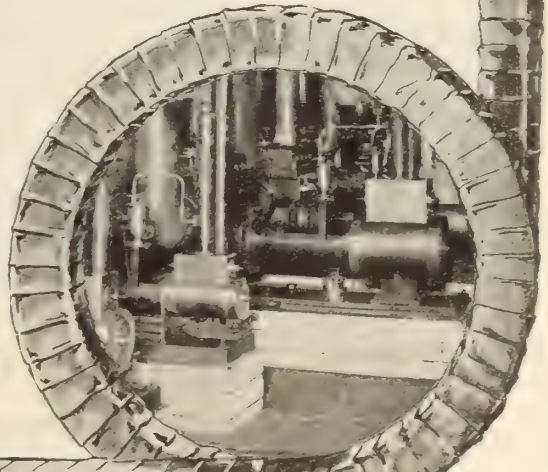
ST. CATHARINES, ONT. *Eastern Sales Offices :* HALL MACHINE CO., Sherbrooke, Que., and Birks Bldg., Montreal

John Crane

Eight Years of Packing Service
JOHN CRANE Flexible Metallic Packing Shows Greatest Results in Constant Service

Eight years ago Chief Engineer, N. Gross, of the Standard Oil Building, Chicago, installed JOHN CRANE Flexible Metallic Packing in the boiler-feed pump pictured below. Mr. Gross reports packing and pump in good order after eight years and has standardized JOHN CRANE on all service.

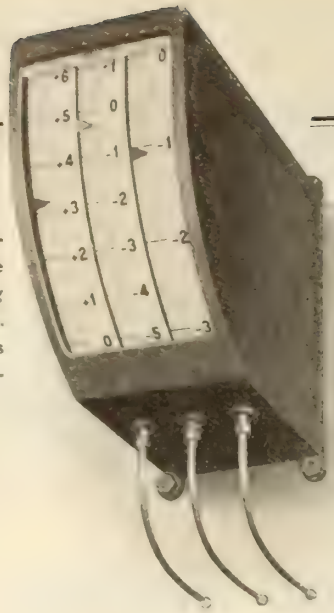
JOHN CRANE holds this long service record because of its scientific, practical construction. Made of babbitt foil and graphite, it brings Packing science "The Babbitt-bearing Principle," and while responding to the slightest pressure of the gland never dries out, but remains compressible and will not score rods.



Write for your copy of "THE ANSWER" a book that tells unusually interesting things about packing problems

The R. C. MILLER OIL & SUPPLY CO.

38 & 40 YOUVILLE SQUARE, MONTREAL



Bailey Three-pointer gauge for comparing draft readings. Other meters for every purpose.

Now---Canadians Can Buy Good Meters at Home

Every man who values good metering equipment will be interested to know that a Bailey Canadian plant is now manufacturing

BAILEY
CANADIAN METERS

This step opens up a vista of opportunities for the prospective meter purchaser. He is now able to purchase meters of national reputation without the necessity of sending Canadian money out of Canada. He will profit considerably by having no customs' entries or rates of exchange to encounter. His orders will be filled and shipped with greater despatch than before possible.

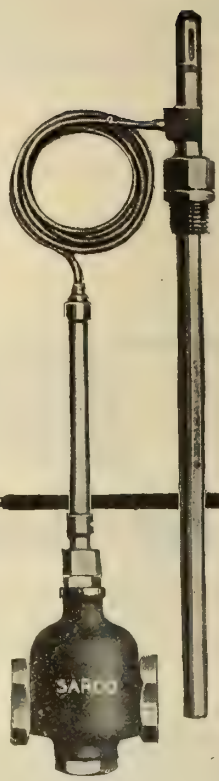
The new Canadian plant is under the supervision of competent Canadian engineers. **They are now ready to co-operate with you.** Bailey Three-pointer gauge for comparing draft readings. Other meters for every purpose.

BAILEY METER CO.

177 Delorimier Avenue, Montreal

SARCO

Temperature Regulator is a Tireless Watchman



It keeps the temperature uniform in your apparatus. From morning 'til night, day in and day out, it steadily maintains the right degree of heat no matter how delicate the process or how trying the conditions under which it works.

At the same time it eliminates spoilage of costly materials due to fluctuating temperatures, and saves valuable time that is otherwise wasted by juggling the crude hand valve as a means of temperature control.

Furthermore, the Sarco demands no wages, observes no clock, and is never subject to exhaustion or breakdown because of unwavering attention to work and watching the temperature.

But best of all, the foreman need give a Sarco Regulator no other attention than a slight adjustment—after which it may be entirely forgotten. You can be sure its highly sensitive and absolutely dependable action will regulate temperature so precisely that at no time during the process will fluctuations be permitted to exist.

And it is so easy and convenient to employ one of these workers for every heating unit you have in your plant. Simply send for a Sarco on trial. It stays for 30 days without cost or obligation, and if it fails to do your bidding, all you need do is to send it back post haste. The trial costs you nothing whatever.

Write TODAY for complete information and Booklet J-61

Sarco Company, Inc.

239 Broadway, New York

Buffalo Chicago Cleveland Detroit Philadelphia

An Efficient, Low-Cost Combination!

Mason Standard Reducing Valve Iron Body

Mason Valves

Mason Standard Reducing Valves reduce and maintain an even pressure of steam or air regardless of the variation of the initial pressure or of the volume of steam or air required. A special socket key permits them to be set to constantly maintain any required pressure within a wide range. Made in bronze for pressures from 5 to 300 lbs. In iron for pressures up to 180 lbs.

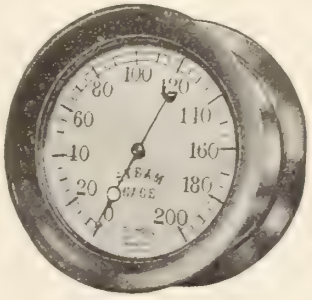
Write to our nearest branch for particulars of these or any other specialties in which you may be interested.

Stratton Separators

Where a thoroughly reliable and always dependable Steam Separator is required, the **Stratton** fills the bill! It is of the centrifugal type and thoroughly eliminates moisture without adding back pressure. Is simply constructed with large receiver capacity.

Ashton Pressure Gauges

Made in many designs for air, gas, etc. **Hand graduated** to insure absolute accuracy. Rigidly inspected.



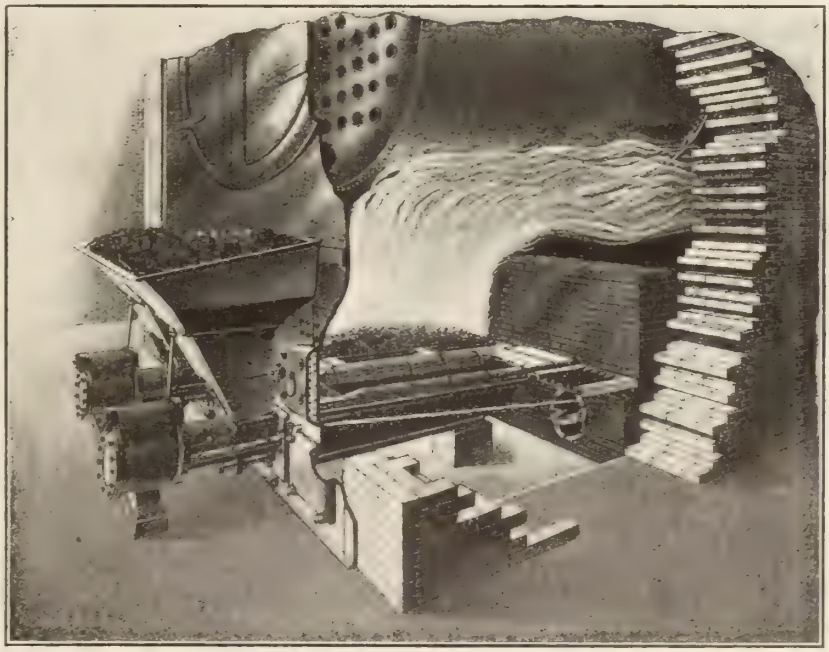
The Mason Regulator & Engineering Co.,
LIMITED
135-153 Dagenais St., MONTREAL, QUE.

Agencies at: TORONTO, Halifax. St.John, Winnipeg, Vancouver

THE
MACLEAN
UNDERFEED STOKER

The Biggest Cost-Cutter in the Plant

The MACLEAN STOKER saves coal and saves labor. It automatically feeds the fire just the right amount of coal at the right time. As a result constant steam pressure is carried regardless of varying loads on the boilers. Every plant, large or small, needs a MacLean Stoker. It responds to sudden demands for steam and maintains a smokeless chimney even when using low grades of coal. It is easy to operate, easy to instal, clean tubes and heating surfaces due to clear combustion. Small cost of upkeep because no moving parts are in contact with the fire.



These and other features enable the MACLEAN STOKER to pay for its installation in a surprisingly short time. Write us and we'll tell you how.

MacLean Underfeed Stoker Company, Limited
95-97 KING STREET EAST, TORONTO, CANADA

Jones

—a type for every plant

THE most important of all power plant problems is the correct burning of coal. In the larger central station, coal constitutes 40% of the total cost of operation. In the average boiler room itself 80% of the total expense is found in this one item.

There is a Jones Stoker for every requirement regardless of the size of the plant or the boiler, the nature of the fuel or the range of the load—whether the plant is old or new. Jones Stokers are also extensively used in various industries for chemical, metallurgical and enameling furnaces, in fact, wherever efficiency, control of heat and smokeless operation are desired.

The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. Through special arrangement the extensive engineering resources of the Under-Feed Stoker Co. of America are made available for Canadian power users. Thus this strictly Canadian stoker is backed by world-wide experience and unequalled engineering ability.

All Jones Stokers are characterized by unmatched simplicity, sturdy construction, and therefore by lower maintenance costs. They consist of one or more simple self-contained retorts with one moving unit, and no moving parts in the fire.

All embody the highest development of the underfeed principle of combustion—originated and perfected in the Jones Stoker. More economy in fuel burning is thus assured with ability to burn all Canadian coals smokelessly.

Every type of Jones Stokers is provided with automatic control of fuel and air, which insures efficiency at all rates of operation. Where stokers are applied to boilers an even steam pressure is automatically maintained. Where applied to industrial furnaces, both the quality and quantity of the heat is controlled.

How can you know which type you need? Read the description of the Jones series.

The Under-Feed Stoker Co., of Canada, Ltd.
81 Victoria Street - Toronto

Alberta, Saskatchewan:
Mr. J. Twomey, Camrose, Alberta
Manitoba:
W. W. Hicks & Co., 567 Banning St., Winnipeg

British Columbia:
E. A. Earle, Limited, 729 Hastings St. W., Vancouver, B.C.

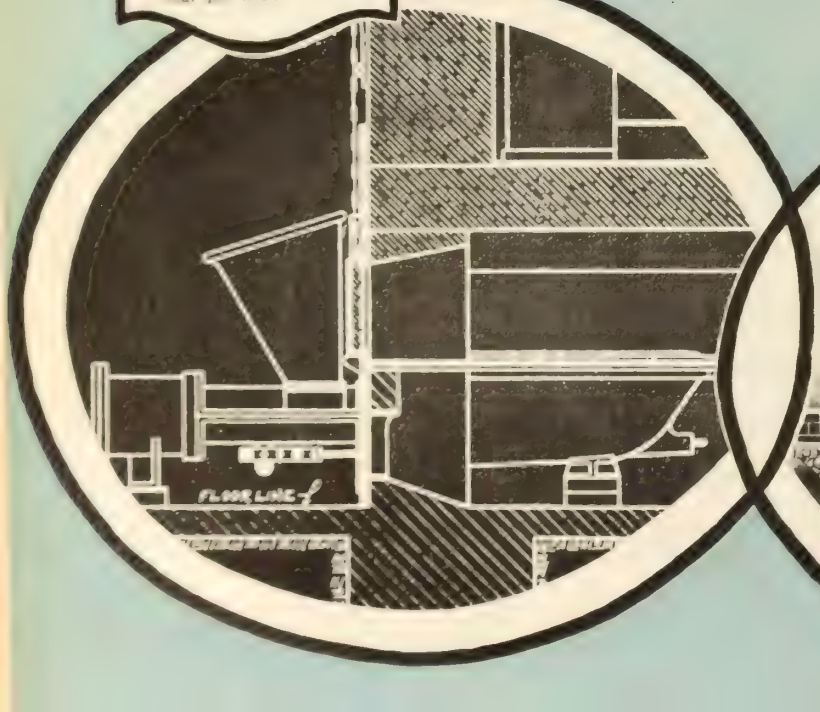
Quebec and the Maritime Provinces:
The Cleaton Co. (Canada), Ltd., 403 Southam Bldg., Montreal, Que.

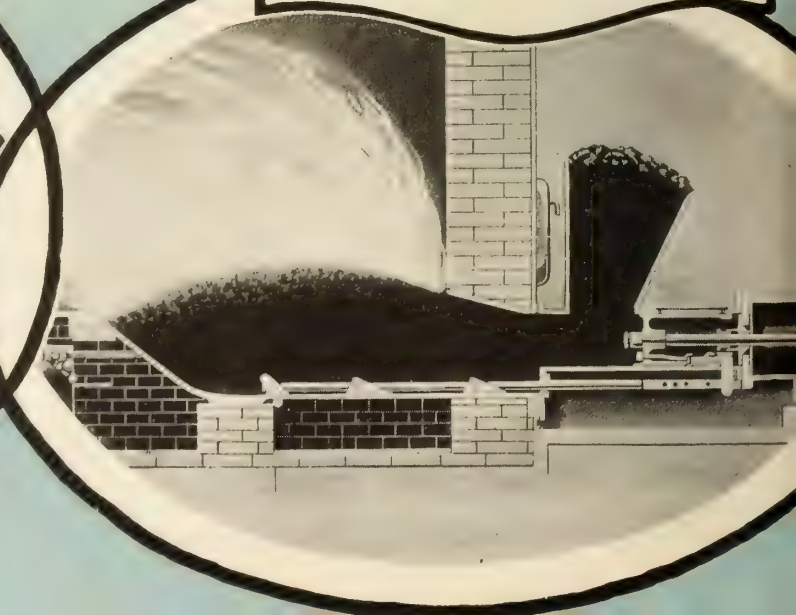
"Light-Duty"

—a small but highly efficient and entirely automatic stoker for use with metallurgical furnaces, chemical processes and smaller boilers. Inexpensive to install. Requires minimum attention. This stoker has a fuel burning capacity of from 60 to 200 lbs. of coal per hour.

"Standard"

—a stoker that embodies the basic Jones features. Moderate in first cost. No special excavation required for ash pit. Simplest underfeed stoker. There are more Jones "Standard" Stokers under Return Tubular Boilers than all other makes of stokers combined. The "Standard" Stoker is widely used for industrial heating furnaces. This stoker has a fuel burning capacity of 1,000 to 1,200 pounds of coal per hour. Single units serve boilers up to 200 H.P.

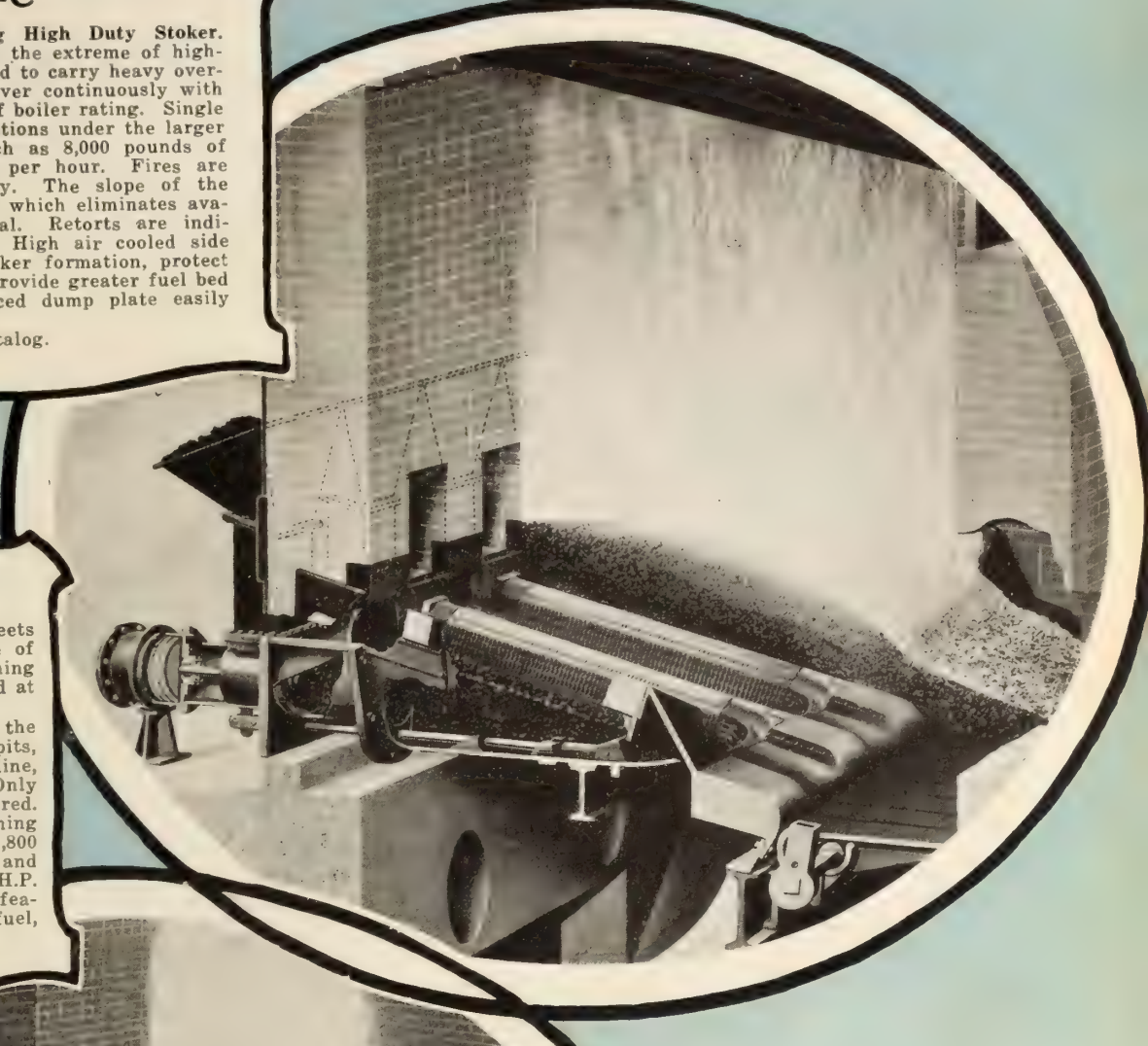




Stokers

"A-C"

— **Automatic-Cleaning High Duty Stoker.** A stoker for meeting the extreme of high-duty service—designed to carry heavy overloads of 200% and over continuously with peak loads of 300% of boiler rating. Single "A-C" Stoker installations under the larger boilers burn as much as 8,000 pounds of coal to each boiler per hour. Fires are cleaned automatically. The slope of the fuel bed is only 11°, which eliminates avalanching of live coal. Retorts are individually controlled. High air cooled side tuyeres prevent clinker formation, protect side walls and also provide greater fuel bed area; simple, balanced dump plate easily operated.
Write for "A-C" Catalog.



"Side-Dump"

— **Self-Cleaning Stoker** meets the needs of a wide range of plants for a self-cleaning stoker that may be installed at moderate cost.
The side dump plates drop the ash into shallow ash pits, slightly below the floor line, permitting easy removal. Only slight excavation required. This stoker has a fuel burning capacity of from 1,500 to 1,800 pounds of coal per hour and serves boilers up to 300 H.P. in size. The basic Jones features make this stoker a fuel, labor and money saver.
Ask for description.

JONES STOKER

Pays for itself— —then pays dividends

REES RoTURBo

Rotary Jet Condensers and Vacuum PUMPS

Sole Canadian Manufacturers

THE REES-RoTURBo products are widely used in Great Britain and United States and are recognized as the very latest development in this class of apparatus, which includes REES-RoTURBo Patent Pressure Chamber Self-Regulating Pumps, Rotary Jet Condensers and Rotary Vacuum Air Pumps.

The Rotary Jet Condenser is used in connection with steam turbines and reciprocating engines. It is particularly adaptable to sugar and salt boiling plants, etc. The Rotary High Vacuum Air Pump is identical in principle with the Jet Condenser and possesses similar advantages. **Made in Canada by the G. & McC. Co. only.**

The engineering profession of Canada is well acquainted with the **quality** in construction that typifies all G. & McC. Co. products—this **quality** is thoroughly maintained in REES-RoTURBo Rotary Jet Condensers and Vacuum Pumps.

Catalogues containing Complete Description will be Mailed on Request

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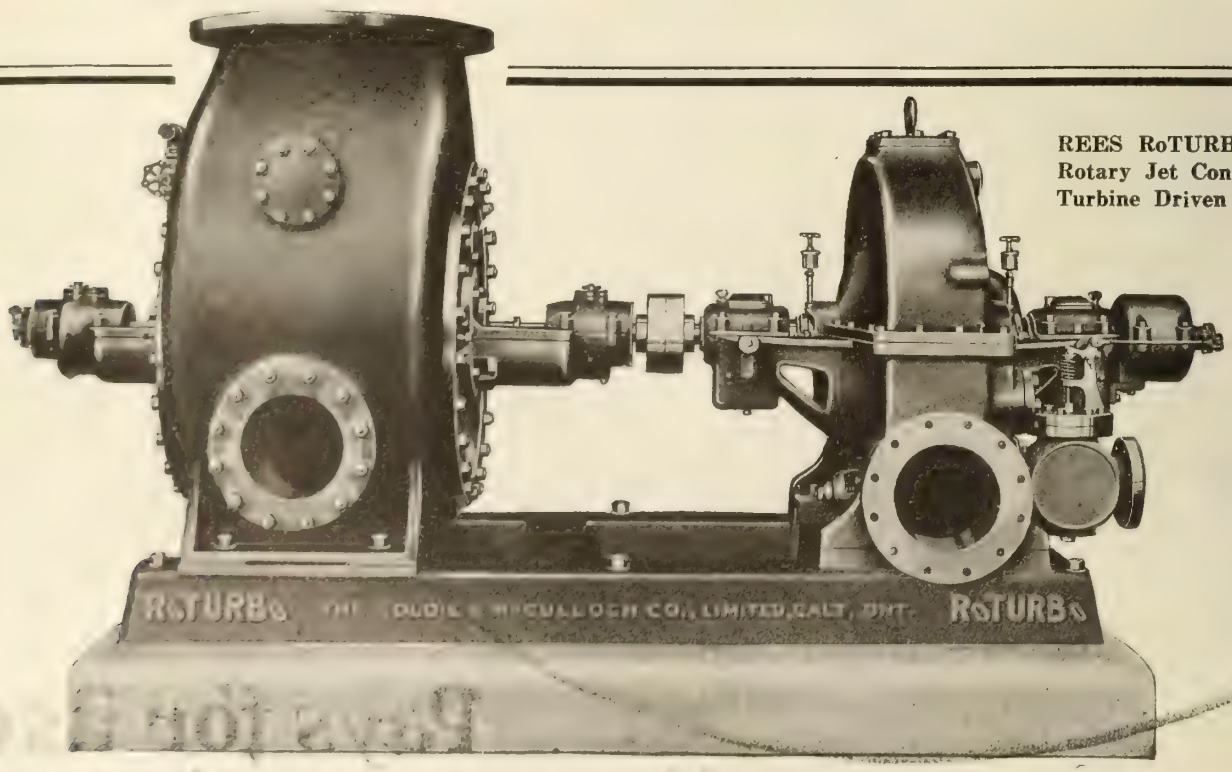


REES RoTURBo
Rotary Jet Condenser
Turbine Driven

POWER HOUSE

Members of the "Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Permanent Statistics for the Power Plant

This Is The First Of A Series Of Articles Dealing With Power Plant Costs And Data. The Method of Recording Details Of Plant And Equipment Are Shown Here

By ROBERT JUNE

COMPLETE permanent specifications of equipment, properly filed, are not found in as many modern power plants as they should be. This is due rather to neglect, or lack of knowledge of how to proceed to keep these statistics in good shape rather than to lack of appreciation of their importance. It is indeed unusual to find the power plant in which the operating engineers do not have some statistics written down in their pocket note books. Every one will agree that the pocket note book is not the place for this data. It should be kept in a formal manner and the records should be available at all times regardless of changing plant personnel.

The keeping of accurate specifications of equipment installed greatly facilitates the making of repairs. It is of great value when the new engineer comes on the job and it has a very important function in the adjustment of fire losses, should such occur.

The presentation of specifications of equipment not only serves as an accurate inventory of the contents of the plant but strengthens the case for the owner and is particularly valuable when the owner has gone to considerable expense to maintain old equipment lost in a fire. Moreover, in the event of a fire, such of the old equipment as it is desirable to replace can be ordered without an instant's loss of time.

The completeness of the specifications should increase with the value of the investment in the plant.

Power Plant Building

Figure 1 indicates the desired specification data on the power plant building. This form is, of course, subject to some modifications, depending on the individual structure. However, all of the information contained in this form should be filed in ordinary cases and if the building is large, additional information will suggest itself.

This information is, of course, of great value in connection with the plan of new buildings and additions, and is also of value to the accounting department in setting up depreciation reserves.

As an illustration of the value of these records, let us suppose that we want to construct an additional building. The specification data tells us where we can match the cut stone or terra cotta trim of the original building. If new equipment is to be installed, we can tell by immediate reference to this sheet what the permissible floor load is. If any of the material of construction, such as roofing, becomes defective, we can readily tell who the manufacturers were and ascertain at once whether a guarantee has been made to cover the life of this particular part.

If we get unusually good service out of flooring, painting, or roofing, and wish to use the same specifications in another building, we can get the data from this sheet.

Power Plant Building Data.

Dimensions: Length .... Width .... Height ....
Type of construction: Steel, concrete, wood, combination .....
Name of general contractor .....
Name of excavating contractor .....
Foundation down to elev. .... Kind of soil with permissible load .....
Floor loads permissible: Engine room ..... Basement ..... Boiler room .....
Masonry contractors .....
Cu. yd. of concrete and proportion used: Foundation .... Yd. prop. .... walls .... Floors ....
Structural steel fabricated by .....
Lb. of steel: Reinforcing .... Structural ....
Common brick .....M. Face brick .....M. Manufactured by .....
Enamelled brick ....M. Manufactured by .....
Cut stone .... cu. ft. Manufactured by ..... from ..... quarry. Sash: Wood ..... Steel ..... Manufactured by .....
Terra cotta cu. ft. ..... Type of roof .....
Guarantee .....
Manufactured by ... ... Ventilators .....
Manufactured by ..... Lighting type .....
Manufactured by ..... Plumbing and heating ..... Installed by .....
Glazing ..... Installed by .....
Painting ..... Installed by .....
Floor preservative ..... Done by .....
Guarantee ..... Manufactured by .....
Completed ..... Total cost .....

Boiler Data

The boiler room is often the heart of the entire plant. If something goes wrong with the boiler, it affects progress in all departments. We need to have complete information regarding the boilers available at all times.

True, we usually have blueprints, or ought to have them. The actual installation, in some instances, may vary from the blueprints, and there is a certain amount of information regarding the boilers to be obtained from the specifications furnished by the manufacturers.

It is possible to put all this information in one place and on a single sheet, Fig. II.

Boiler Data.

Plant No. ..... Builders' No. .....
Location .....
Manufactured by .....
Factory address .....
Nearest office address .....
Man to call regarding repairs ..... Phone ....
Date installed ..... by whom .....
Type .... Weight boiler .... Weight water ....
Tubes, No. ..... Diameter ..... Length .....
Made of ..... Steam pressure gauge .....
Safety valve: (Pressure ..... .Type .....
Diameter ..... Number .....). Steam space, cu. ft. ..... Water space, cu. ft. .....
Heating surface, sq. ft. ..... Superheating surface, sq. ft. ..... Area of grate .... Type of grate or stoker ..... Rated horsepower.. ....Ratio of heating surface to grate area....
No. of steam drums .... Dia. of steam drum in. ..... Thickness of shell, in. .....
Thickness of heat, in. .... Type of joint .....
Dia. of steam nozzle in. ..... Dia. of blow-off, in. ..... Dia. of feed pipe, in. .....
Temperature of feed water .... Type draft .....
Maximum draft ..... Height of setting .....
Length of setting .... Thickness of Walls ....
No. of fire brick ..... Number of common brick ..... Distance between batteries ....
Distance from back of boiler to wall .....
Distance from front of boiler to wall .....
Manufacturer's guarantee .....
Combined boiler efficiency: 100 per cent rating ..... 200 per cent. rating ..... 300 per cent. rating .....

Economizer Data

If economizers are installed in connection with our boilers, we want the data concerning them to be as readily available as that of the boilers.

If economizers are equipped with scrapers there is frequent need to make replacements and we also want the manufacturers to guarantee this equipment for us so that we can check up the performance of the equipment.

Figure III gives us this essential information.

Economizer Data

Plant No. ... ... Builder's No. .....
Location ... .
Manufactured by .....
Factory address .....
Nearest office address .....
Man to call regarding repairs .... Phone .....
Date installed ..... by whom .....
Type ..... Weight economizer .....
Weight water ..... Tubes, No. .....
Diameter ..... Length ..... Made of .....
Heating surface per sq. ft. boiler heating surface, sq. ft. ..... Heating surface per boiler horsepower (34.5 lb. water per hr.) rated capacity, sq. ft. .....
Cleaning: If by scrapers.
Type motor ..... H.P. ..... A.C. or D.C. .....
Voltage ..... R. P. M. ..... Make motor .....
From whom purchased .....

Name and address to call regarding repairs ....
... If by mechanical soot blowers.
Make of soot blower ... Type ....
No. of units ..... Size riser pipe ... ...
Size header ..... Make and size of valves ..... Name and address to call regarding repairs ....
Manufacturer's guarantee: Feed water lbs. per ... pressure leaving economizer when ... at ... deg. F. Gas temperature entering deg. F. ..... Gas temperature leaving deg. F. ..... Gas temperature difference ....

Soot Blower Data

The economical soot blower insures high boiler efficiency and they save fuel. They are an essential part of our equipment and it is extremely important that we should keep the blowers in the best operating condition at all times.

A sheet made out in accordance with Figure IV gives us all of the essential data on this important piece of equipment.

Soot Blower Data

Boiler No .....
Location ....
Manufactured by .....
Factory address .....
Nearest office address .....
Man to call regarding repairs .... Phone ....
Date installed ..... By whom .....
Type ..... Trade name .....
Number of calorized units .....
Number of plain units .....
Diameter of header .... Diameter of risers ....
Diameter of drains ..... Location of units (see blue prints) .....
Dia. of nozzles ..... Type of nozzles .....
Make of main valve .....
Make of individual valves .....

Condenser Data

In Figure V we have a typical figure to keep our condenser statistics. Here we have all the necessary data on length, diameter, and thickness of tubes, data on circulating, dry vacuum and hot well pumps, capacity of the condenser, etc.

This information is of great value to the operating force.

Condenser Data.

Plant No. ..... Building No. .....
Location ....
Manufactured by .....
Factory address .....
Nearest office address .....
Man to call regarding repairs .... Phone .....
Date installed ..... By whom .....
Type ... Weight condenser ... Weight water...
Tubes No. .... O. Diameter .... Thickness ....
Length ..... Made of ... .. Cap. lb. steam per hr. at ..... in. vac. and cooling water at ....deg. F. Steam condensed per sq. ft. of surface, lb. ..... Total tube surface per con... ft .....
Manufacturer's guarantee: with gal. 70 deg. ctr. water, vacuum in condenser ..... in. .....
Hot well temperature ..... Cross sectional area intake tunnel ..... sq. ft. .... Discharge tunnel .... sq. ft.
Circulating pumps .....Type.....
M... ... ...

The Gas and Oil Engine in the Power Plant

This Article Deals With The Difference In The Two And Four Cycle Type Of Engine, Gasoline, Semi-Diesel, And Diesel, And Some Illustrations Of These Types

By T. H. FENNER

IN THE first article on this subject, the general features of the internal combustion engine as compared with the steam engine were discussed. Its efficiency as a heat engine was shown to be much higher than that of the steam engine, and the reason of this explained.

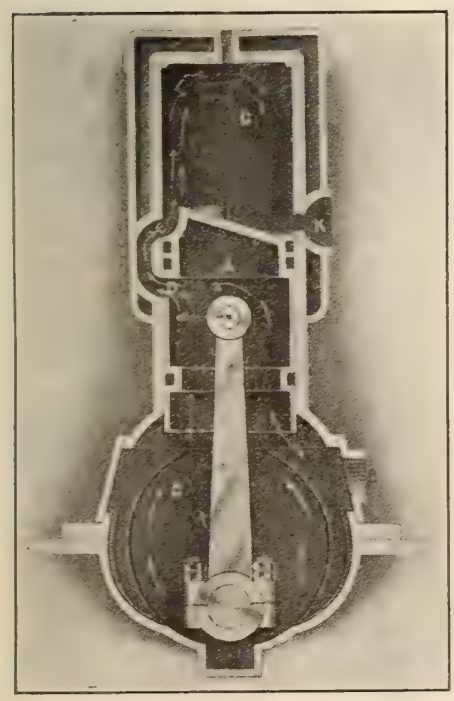
We can now go a step further, and discuss the two important types of internal combustion engine, which are the two cycle and the four cycle respectively.

The Two Cycle

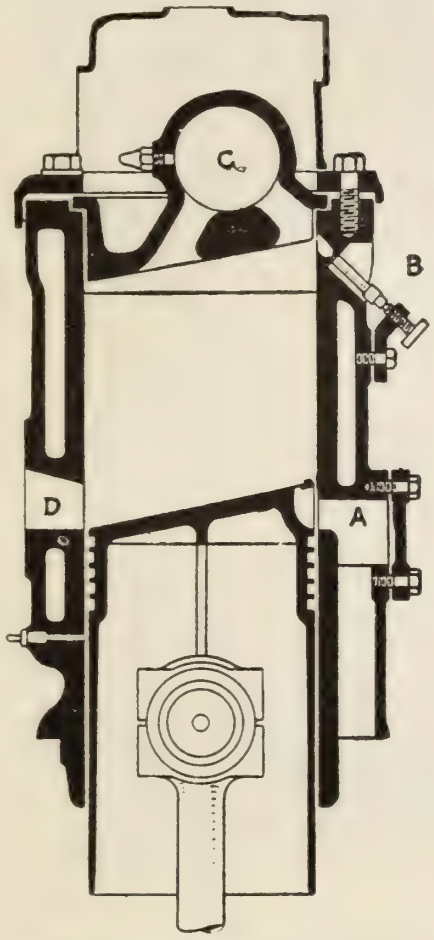
In every gas, gasoline, or oil engine there are four functions to be performed, which constitute what is known as the cycle. These functions are as follows:—drawing in the charge, compressing the charge, explosion of the charge and expulsion of the burned gases or exhaust. These functions may be stated shortly as suction, compression, expansion and exhaust.

In what is called the two cycle system these functions are performed during two strokes of the piston or one revolution. That means that every second stroke is a working stroke or to state it another way, there is an impulse at every revolution of the crank. The correct definition of this type of engine is "an engine working on a two stroke cycle," but common usage has abbreviated this to two cycle.

We can now examine the action of a



Section through small 2-cycle motor, showing path of gas.



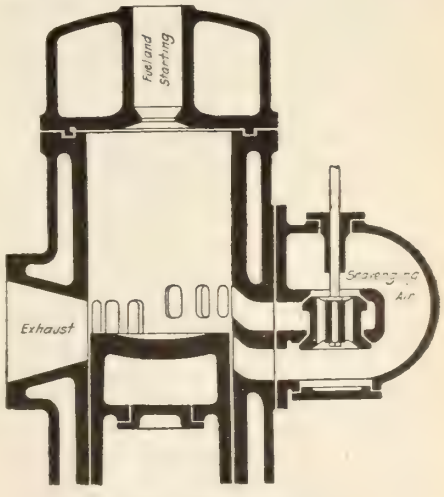
Bolinder Semi-Diesel Engine. A, Scavenging Port. B. Spray Valve. C. Hot Bulb. D, Exhaust Port.

charge in an engine of the two cycle type, and the various methods employed to get a full expulsion of the burnt gases, so as to leave the combustion chamber clear for the introduction of the new charge.

One of the principal features of the two cycle engine is that it requires no valves for the admission or expulsion of the charge and the products of combustion. The necessary openings at the proper times are controlled by the piston itself, which alternately covers and uncovers ports which are cast in the cylinder. In the smaller types, such as small marine engines, and in the semi-Diesel types, the piston on the down stroke compresses the air in the crank case, and at the instant the exhaust port opens or immediately after, the fresh charge is forced through the inlet port, helping to eject the burnt gases in the combustion chamber.

The illustration Figure 1 shows a cross section of a small two cycle gasoline motor. The piston is shown on the bottom of the stroke, and the charge is shown being forced up through the admission port D into the combustion chamber. It will be noticed that the piston is stepped, that is one side is higher than the other. This ensures the exhaust port K being opened for the passage of the exhaust gases before the admission port is opened, and the shape of the piston also tends to throw the incoming charge to the top of the combustion chamber, while the remainder of the burnt gases are being expelled. The fresh charge is drawn in through the inlet port B into the crank case on the up stroke of the piston, while the charge already present is being compressed. At the top of the stroke the charge is ignited, in this case by means of the electric spark plug, and the piston descends on its power stroke. When the piston has gone down a certain distance the exhaust port is opened, and immediately afterwards the piston opens the port on the other side, to admit the mixture of gasoline and air that is being compressed in the crank case. Thus each time the piston reaches the top of its stroke an explosion occurs, giving a power impulse at each revolution.

Figure 2 illustrates a cross section of the "Bolinder" semi-Diesel engine of the two cycle type, which is also furnished with crank case compression for scavenging, but in this case the fuel is injected by a pump through the spray valve B. In this case the piston also



Sulzer Diesel Engine Two-Cycle.

effects the uncovering of both ports for exhaust and scavenging. The port A connects with the crank case, and the descending piston compresses the air in

the crank case and forces it up through the port as the piston descends. The exhaust port D being above the port A is opened by the piston first, and the exhaust gases pass out being assisted when the piston uncovers the port A by the air under pressure rushing up from the crank case. The circular portion of the cover C is the hot-bulb, which is uncooled, thereby retaining sufficient heat to ignite the fuel when it is injected through the spray valve.

The cylinder walls and the cover with the exception of the hot-bulb, are water cooled. This hot-bulb constitutes the chief difference between the full Diesel type and the semi-Diesel. It is necessary because the compression pressure and temperature in the semi-Diesel are only half of that in the full Diesel, therefore the temperature is not sufficient to cause ignition of the charge.

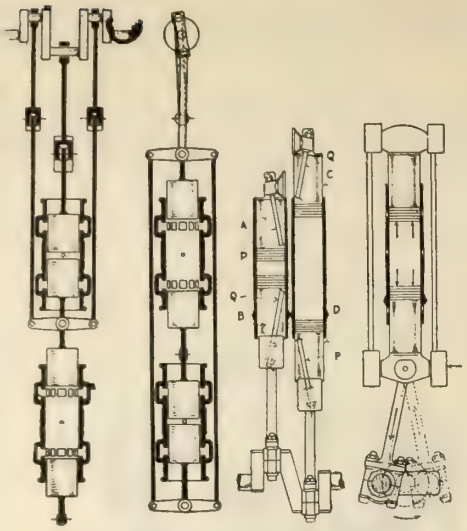
In some types of Diesel engines working on the two cycle principle, the scavenging is performed by means of special pumps worked off the engine itself, which raise the pressure of the air to about 10 or 15 lbs. above the atmosphere thus ensuring a positive scavenging action. This is a most important thing in a two cycle engine, as if the products of combustion are not fully expelled from the cylinder before the fresh charge is ignited, incomplete combustion, with a waste of fuel and power are caused.

Figure 3 is a cross section of the cylinder of the Sulzer Diesel engine, also a two cycle type. The fuel injection is from the top of the cylinder, and in addition to the exhaust port, there are two tiers of scavenging ports. The opening of the lower tier of scavenging ports and the exhaust are controlled by the piston, but the admission of air to the scavenging ports in the upper row is controlled by the valve shown on the side, which is operated by a timed cam. This valve is timed to open at about the time that the lower ports are uncovered by the piston, and can be arranged to close at any time between the covering of the top row of the ports by the piston and the end of the up stroke, or before the piston uncovers them on the down stroke.

The loss of power from the use of special pumps for scavenging air is about the same as the extra power consumed by crank case compression, and constitutes a small portion of the power developed.

The chief advantages claimed for the use of the two cycle system are that a much greater amount of power can be developed in a cylinder of the same size than in the four cycle type, and the absence of any valves makes it simpler of construction, lighter and cheaper.

Aginst this there is the question of efficient scavenging, which is admittedly difficult to obtain, and the absence of which lowers the efficiency of combustion. The cylinder wall surface is greater in comparison to volume in the



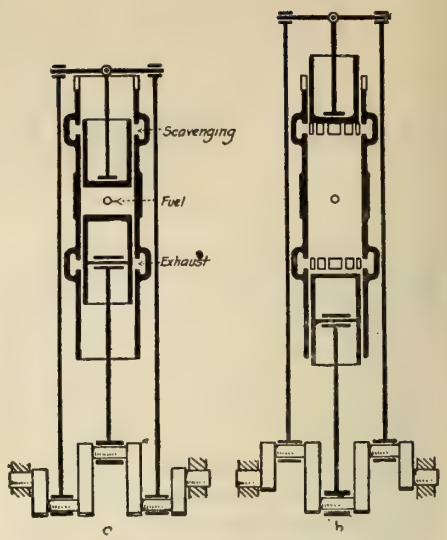
Left.—Junkers Tandem Type.
Right—Cammell Laird Fullagar Engine.

two cycle than in the four cycle, and allows a greater amount of heat to be carried off by the circulating water, which again allows of a higher compression pressure being attained, which of course tends to increase efficiency.

There are schools which favor both types, and both types are being built in large sizes, so the question does not allow of any definite pronouncement in favor of one or the other. Several engines of the two cycle type have been developed on the opposed piston principle which is known as the Junker principle. This consists of two pistons in the same cylinder, the combustion chamber being between the two pistons. When the charge is ignited one piston goes down while the other goes up, the top piston working a crosshead which is connected to two cranks by side rods, the lower piston being connected to the centre crank. In this design there are no cylinder covers, the top and bottom of the cylinder being open to the atmosphere. Another type of this principle is the Fullagar engine, developed by the Cammell Laird Co. in England. In this engine the pistons are connected by diagonal rods, the top piston in one cylinder being connected to the bottom piston in the other. Only two cranks are necessary with this engine, and the top piston carries a square guide which is used for compressing the scavenging air.

The Four Cycle Type

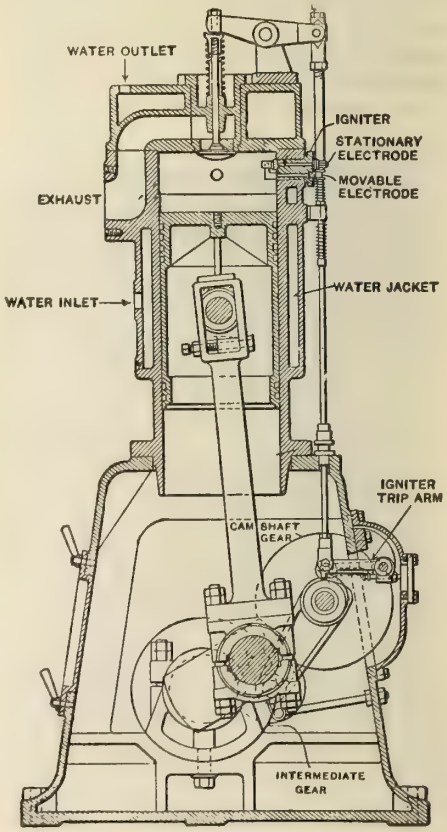
The four cycle type of internal combustion engine differs from the two cycle type in that it receives an impulse only on every fourth stroke, or every two revolutions. It also differs in that it has to be fitted with inlet and exhaust valves for the admission and expulsion of the charge and the products of combustion. On account of the exhaust and charging strokes being entirely separate, the scavenging is complete, and is performed entirely by the piston. There is no connection between the crank case and the chamber as in the two cycle type. It is heavier



Junkers Diesel Engines.

and more complicated than a two cycle engine of the same power. Opening and closing of the inlet and exhaust valves are positively controlled by cams on a shaft which is operated by gearing from the crankshaft of the engine. It is generally considered more reliable than the two cycle type for small high speed motors, but in the larger sizes, and especially in the full Diesel type, the two cycle is about on a par with the four.

In the four cycle type the events occur as follows. On the down stroke of the piston a charge is drawn in through the suction valve. On the upstroke the suction valve closes and the charge is compressed. Firing occurs at the top of the stroke, by means of



Section Through 4-cycle Gasoline Engine.

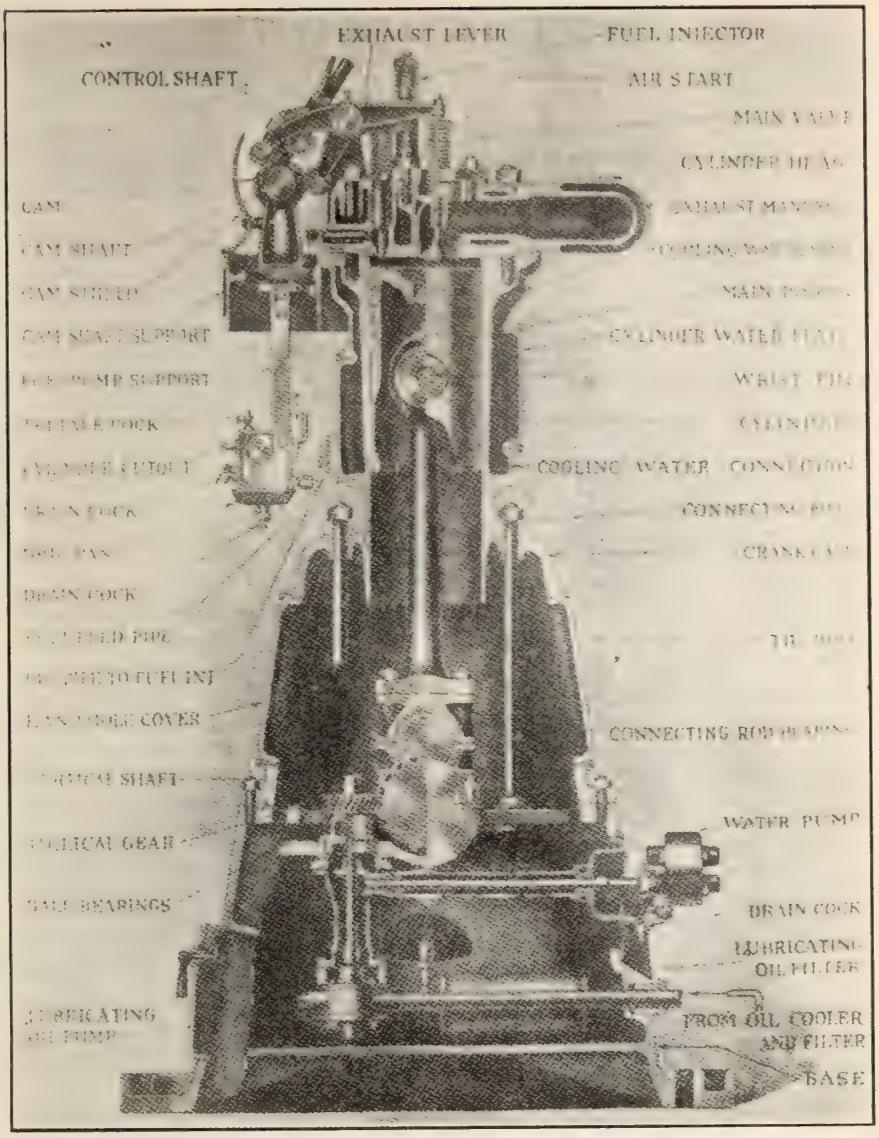
electrical ignition or hot-bulb, or compression according to the type of engine. The third stroke is the working stroke, and on the fourth stroke the exhaust valve opens, and the exhaust gases are expelled by the piston coming up in the cylinder. Thus there is only one power stroke at each two revolutions.

The illustration herewith is a cross section through the cylinder of a full Diesel engine of the four cycle type, as made by the Dominion Steel Products, Brantford. The various parts are shown clearly in the cut. In this type of engine the ignition is performed by the temperature of compression, the air in the combustion chamber being compressed to a pressure of about 500 lbs. per square inch by the ascending piston. The fuel is injected against this pressure by means of a fuel pump, which injects the fuel at a pressure of about 800 lbs. per square inch, and it is atomized by a jet of air furnished by the air compressor which supplies air at about 900 lbs. per square inch. The air compressor is driven off the crank shaft of the engine itself, and is a three stage type. Air is used also for starting, and when the engine is running a reserve supply of air is accumulated in steel bottles or cylinders, this air being available for starting up when required.

In some types of Diesel engines the fuel is injected in a solid jet, the compressed air being used only for starting purposes. This latter type is known as the solid injection type of engine, while the other is known as the air injection. Both these systems have their champions, the Holly injection school claiming the elimination of the air compressor after the engine is once started, and the air injection men claiming better combustion due to the more efficient atomisation of the fuel charge. These advantages about balance each other, and like the controversy between two and four cycle, honors are about even.

There is this great difference between the Diesel type of engine and the ordinary gas or gasoline engine, apart from the method of ignition. In the Diesel engine the charge is ignited and burns for a certain portion of the stroke while the pressure remains constant. In the gas or gasoline engine, the charge is virtually exploded, a considerable rise of pressure occurring at the instant of ignition. Thus in one case combustion takes place at constant pressure, while in the other it takes place at constant volume. The cards from these different types show this plainly, and in later articles we shall give some examples of this.

A cross section of a vertical four cycle gasoline engine is shown in the following cut. The exhaust valve can be seen and the inlet valve is behind this so is not shown. There are only the two valves, inlet and exhaust, there being no need of a fuel injector or air



Section through 4-cycle Diesel engine, Dominion Steel Products.

starting valve, etc., with this type. On large sizes of engines it is usual to install means of starting by compressed air, but on small types starting can be effected by means of a lever on the fly wheel. This is possible owing to the small compression pressure, as compared to the high pressures of the Diesel or semi-Diesel engine. The electrical ignition device can be seen in the side of the cylinder, while the timing shaft is shown working from the crank shaft. The drive is accomplished in this case by means of a chain, instead of bevel or spiral gearing. These two illustrations give a good idea of the general construction of these two types of four cycle engine, but of course it must be understood that practically every maker has some modifications of design that have been developed by themselves.

This article and the preceding one having dealt with the general characteristics of the internal combustion engine, we shall show in our following article some typical examples of different makes, with a brief description of each.

The Newfoundland Government is negotiating with the Armstrong-Whitworth Co., of England and the Reid Newfoundland Railway Co., with regard to the previously announced project to create a water power development totalling 235,000 h.p. on the west coast of Newfoundland. This would be utilized for the establishment of a paper mill with a capacity of 400 tons of newsprint daily; a factory for smelting aluminum with a capacity of 15,000 tons yearly, and other industries.

Preparatory to the commencement of building operations on the new five million dollar plant for the Western University, London, Ont., the board of governors have arranged for the enlargement of the new campus by the purchase of 30 acres of adjoining property. The site thus grows to 230 acres.

Mr. C. Lovatt, 1537 St. Denis St., Montreal, Quebec, is in the market for one 25 h.p. steam boiler.

The Mount Royal Arena, Montreal, Quebec, is in the market for equipment for an artificial ice plant.

For Better Boiler Room Operation

This is the Conclusion of the Paper, First Part of Which Appeared in the Issue of December 20—It Deals With the Instruments Used

By C. W. DEFOREST
Read before the Stoker Manufacturers' Association.

THE following is a description of the instrument and records in use at our plant. It is not intended to convey the impression that it is the best system. It is far from perfect, and we are continually trying to simplify and improve it. However, it serves to show how data are obtained and used at the Cincinnati plant.

Feed Water to the Boilers

The quantity of water fed to the boilers is measured by a Venturi Meter. From the meter chart the pounds of water entering each boiler can be calculated. Valve leakage can be found by co-ordinating this chart with the steam flow chart.

Steam Flow from Boiler

Steam flow from boilers is measured by General Electric flow meters by the use of which the equal division of the load on the boilers is made possible. It also enables the fireman to know that he is operating the boiler at its most efficient rating, which has been decided upon by tests. In addition, the pounds of steam generated can be calculated for future calculations on plant efficiency.

Steam Temperature from Boiler

The steam temperature from the boiler is indicated by a Foxboro recording thermometer. The degree of superheat is calculated from the data obtained on this chart. In addition, it serves the purpose of indicating leaks in baffle work and also the condition of the superheat.

Temperature of Water Entering and Leaving Economizer

The work done by the economizer is determined by the temperatures as recorded on the chart of a Foxboro Recording Feed Water Thermometer. Other information obtained is, factors of evaporation for use in future calculations, condition of economizers; it also gives the operators knowledge as to what combination of auxiliaries to run so as to maintain the correct value of temperature of the inlet water to the economizers.

Temperature for Gases Entering and Leaving Economizers

The information obtained from the chart of Foxboro Recording Pyrometer which measures the temperature of gases entering and leaving the economizers is, whether or not the baffling leaks; whether soot blowers are properly operated; condition of the boiler, superheater and economizer; and whether or not the economizer is operating with a high efficiency. The values of temperatures are also used for heat balance calculations.

CO_2 at Boiler Outlet

The percentage of CO_2 at the boiler outlet is recorded on the chart of a Foxboro-Heath CO_2 Recorder. Uniformity in firing, proper admixture of air into the furnace, condition of boiler and furnace settings, are indicated by this chart. In addition, it helps in building up an efficient firing force, as a check on each fireman can be obtained. The inefficient ones can be picked out and properly trained or replaced. The main purpose of the chart is the saving of fuel.

Pressure at Main Boiler Room Steam Header

This is recorded by a Bristol Recording Pressure Gauge on a chart which indicates the uniformity in boiler operation, and enables the firemen to regulate the load on the boilers to meet the fluctuating demands for steam. It is also used for calculation purposes.

Level of Water in Treating Tank

A graphic chart indicates to the operator the amount of water in the Scaife Treating Tank at any period of the day, enabling him therefore to be on hand when the tank is empty or being filled so that no waste of water results. The various operations of water treating are recorded on the chart and can therefore be checked.

The source of make-up water is the clear well. It is, therefore, essential to know at all times the amount of water in this well. A chart records the water on hand at all times.

Flow of Water Used for Make-up

A V Notch Recorder indicates the quantity of make-up water used. It is valuable in that it assists in determining condenser leakage or valve leakage. It indicates the periods during the day or week when the demands for make-up water are heaviest, thus enabling corrective measures to be made,

Steam Flow to Turbines

The water rate on each turbine can be determined at all periods from the chart of a General Electric Flow meter. Calculations of pounds of steam into each turbine are necessary for calculation on plant and unit efficiencies. Information relative to the condition of the blading is obtained by the indication of high or low rates. The data obtained are used in conjunction with the boiler steam flow for determining the per cent. steam used by the auxiliaries.

Temperature of Steam to Turbine

The degree superheat of the steam to the turbine is obtained from the chart of a Bristol Recording Thermometer. The information is necessary for calculating the total heat of the steam. This chart will also indicate the quality of steam supply to the turbine.

Boiler Room Log Sheet

All data pertaining to boilers on line, banked or out of service, are noted on this sheet. Periodic readings of stoker counters and integrators are also entered on the log. It is used in the calculation of banked hours, service hours and coal used. In addition, it keeps the operator in close relation with the specific work in that he is required to take periodic readings. Taken together, the log sheets form a history of operation and are valuable for reference.

Economizer Log Sheet

This sheet is made out by the economizer tender and is an hourly report on the condition of fan and motor bearings and the mechanism operating the soot scrapers.

Pump Chart

Temperatures of water from feed heaters, feed water pressures, and pump operation are the data obtained from this log sheet. Readings are periodic.

Coal Slips

The amount of coal put into each bunker is obtained from these slips. The data is used for calculating boiler and plant efficiences and coal in storage. Used in calculating Daily Cost Report.

Turbine Room Log

All data pertaining to load, vacuum, oil temperatures, and all other facts of operating conditions are periodically recorded on this log sheet. The calculated results are used in the calculation of plant and unit efficiencies. Here, too, the operator is brought into a closer relation with the work due to the taking of readings. For reference purposes, this log is very valuable.

Daily Coal Report

The purpose of this report is to bring to the superintendent, daily, in a condensed form, all facts pertaining to coal handled on the preceding day. This includes coal received, coal used and coal distribution. The coal storage is therefore known from day to day.

Boiler Room Service Record

This record is prepared daily from the Boiler Room Log and indicates the number of banked hours, on line and total service hours for each day, for the month to date, and since the boiler was washed or bored. From these cards we find which boiler is next due for boring or washing.

Boiler Room Operating Record

The following items of boiler per-

performance are calculated daily for each boiler: hours on line and banked; fuel fired; steam generated; evaporative factor; actual and equivalent evaporation per pound of fuel; boiler rating; boiler and economizer efficiency; per cent. of horsepower developed by economizer.

Turbine Operation Record

The following items of turbine performance are calculated daily for each turbine: hours in service; K.W.H. generated; steam used; load factor; water rate; efficiency of unit; heat transfer of condenser and average circulating water in gallons per minute.

Daily Station Report

All items recorded in the boiler operating records are copied daily on the daily station report, together with the following calculations: total fuel fired; coal per K.W.H. generated and K.W.H. S-O; B.t.u. per K.W.H. generated and K.W.H.S-O; station net thermal efficiency; load factor; peak; and coal and ash analysis.

Boiler Repair Report

This report shows why a boiler was taken out of service, when it came off and when it was back on the line, and what work was done. The work is divided, into—tube replacement, boring tubes, and repairs to brickwork, stoker, piping and valves, and miscellaneous. The cost of work is divided into labor and material charges, and unit costs are calculated where possible.

This system of charts, log sheets and records has been developed with the intention of taking all data which affect the operation of the station, working it over into a set of compact records of each unit of equipment, and presenting these facts daily to the superintendent in such a condensed form that he may keep in close touch with the operation of the station without going over the mass of charts and log sheets.

Conclusions

In conclusion, the following conditions which are vital to better boiler room operation should be emphasized.

1. The best performance of stokers and boilers can be obtained only by employing high grade operators and technically trained combustion engineers;

2. The labor cost for boiler room operation and superintendence is only 2 or 3 per cent. of the total cost. Therefore, it is not the determining factor in the cost of producing power;

If we maintain the maximum efficiency of the plant as a whole, each individual link in the chain of equipment must be kept in good condition;

4. In order to obtain maximum efficiency, such records must be kept of each piece of equipment, as will enable us to know when its performance is dropping below standard.

C. A. S. E. TORONTO LODGE

Second Set of Competition Questions and Answers

Question:—Name the types of boilers in common use, divide into classes, and name the advantages or disadvantages of each class or type under different conditions or load.

Answer:—Horizontal return tube, fire-box, vertical tubular, semi horizontal; fire tube, water tube and fire-box combination with either. The fire tube boiler is suitable for steady load conditions: the water tube boiler is more suitable for varying load or overload conditions.

Question:—What is meant by the surface ratio of a boiler?

Answer:—The surface ratio refers to the ratio of heating surface to the accepted basis for determining capacity, viz:—the ratio of heating surface in H. R. T. boilers is 15 sq. ft. per horse power and the ratio of water tube boilers is 10 square ft. per horse power.

Question:—What is meant by the efficiency of a boiler? What efficiency is usually obtained in properly proportioned boilers with clean heating surfaces?

Answer:—The relation between the "input" (heat of the coal) and the "output" (evaporation of steam,) determines the efficiency; after allowing for certain variables such as temperature of atmosphere and feedwater. The average of 75 per cent. is good and 85 per cent. is very good.

Question:—What is the difference between natural draft, induced draft, and forced draft?

Answer:—Natural draft is obtained by means of high chimneys or smoke stacks but there is a limit to the amount of a given kind of coal that may be burned per square foot of grate surface. Induced draft is obtained by means of suction fans and while it does not greatly increase the boiler capacity it does often eliminate the cost and need of high chimneys or smoke stacks. Forced draft is obtained by blower fans or steam jets and often accomplishes both results, i.e. of increasing the amount of coal that may be burned per square foot of grate surface per hour and avoiding the necessity of chimneys. It also incidentally increases the boiler capacity but the efficiency falls as the forcing increases above certain well-known standards.

Question:—Name two or three methods of producing forced draft. What are the advantages and disadvantages of forced draft?

Answer:—Blower fans, (air pressure), saturated steam jet inducing air and resulting in combination of steam and air blast; also superheated steam and preheated air combination of steam jet. Makes boiler operation independent of atmospheric conditions, but results in higher furnace temperatures than either natural or induced draft.

Question:—What is a mechanical stoker? Give definition and description. What are some of the advantages claimed for mechanical stokers?

Answer:—Any mechanical means of conveying the coal into the fire-box ready for burning may be said to be a mechanical stoker, and they consist of steam operated plungers and pushrods situated in a retort, inclining and moving bars or inclined and stationary bars with clinker breaking or ash dump in centre between the two inclined sides. The advantages of these stokers are that cheaper fuel may be used. It is fed in constantly and regularly, insuring better combustion, and the fire doors are eliminated or seldom used thereby eliminating many objectionable features and losses.

Question:—Into what general classes may mechanical stokers be divided? Point out the difference or advantage of each type.

Answer:—Overfeed and underfeed. In the underfeed type the point of distillation of gases is above the green coal and under the incandescent or hot fires; whereas in the overfeed type the point of distillation is changing from the centre to the top; however, best results are being obtained where the incandescent condition is uniformly at the top of the fuel bed.

Question:—Name two methods of producing induced draft?

Answer:—Steam jet in smoke stack or suction or exhaust fan. The advantages of induced draft are: cost of boiler setting is greatly reduced over that of forced draft; considerable saving can be effected by using shorter chimneys. Disadvantages of induced draft are: the boiler setting must be kept tight, (no air leaks) means of producing the induced draft have to be provided just the same as in the case of forced draft and an interruption to the driving power of same seriously handicaps the operation and capacity of the plant.

Question:—What points should be considered in the selection of boilers for a given plant? Give at least two examples stating reasons for the choice fully.

Answer:—The points to be considered are: the floor space available and head room; also the nature of the load or demand, as to whether it is steady or variable and the range of same; further, the type of fuel to be used and the topography of the country, its relation thereto as to draft, etc.; finally, the water supply should be considered as to scale and its removal. Where load is steady and the draft good, fire-tube boilers may be operated to advantage with almost any kind of fuel, if there is ample heating surface provided. Where the load is variable and liable to heavy demands water tube boilers could be utilized to advantage and forced draft substituted for natural draft.

Testing of Locomotive Superheater Units

THE USUAL method of testing superheater units by means of the cold water pressure method is to use a pump to obtain the necessary pressure. However, in the Grand Trunk Railway Shops at Point St. Charles, Montreal, a clever apparatus for testing these units has been constructed whereby the pressure is obtained from the regular high pressure hydraulic lines of the shops. This does away with the necessity of a special pump. Two other outstanding advantages are the facts that the work is accomplished in perfectly dry surroundings, and that the water is completely expelled from the units into a pit at the conclusion of the test, which is accomplished in a remarkably short time.

The sequence of operations, perhaps, would be the best method of describing the apparatus and its method of functioning. First the unit is clamped by one "T" headed bolt to one side of a "T" casting which takes the place of the superheater header in actual service. The 45 degrees bevel seat in the casting fits the spherically ground end of the unit. The outer end of the unit is supported on a special adjustable stand.

It might be well to mention here that the apparatus is of a dual nature. There are two sets of seats for units to be tested. While a unit is being removed and another one attached to one side, testing operations are being carried on, on the other side of the apparatus.

As soon as a unit is clamped in position, a valve "A" (Fig. 3) is opened that lets city water into the unit. At the same time the lever valve "B" (Fig. 1.) is opened which permits the air to be expelled from the unit. (It will be noted that water entering one arm of the unit through valve "A" expels air through the opposite side of the unit.) To this latter valve an overflow pipe is attached leading down into a pit below the floor, but the end of this pipe is at the same time in open sight, as will be seen in Figs. 1 and 2. When the unit is filled with water a solid water discharge from this overflow is seen. Then the valve "B" in the overflow line is closed. Immediately the full city pressure is conveyed to the unit, the level valve "C" (Fig. 1.) is then opened and its corresponding valve on the opposite side of the apparatus is closed. The gauge now registers the pressure in the unit as supplied by the city mains. Following this the city pressure is cut off by closing valve "A".

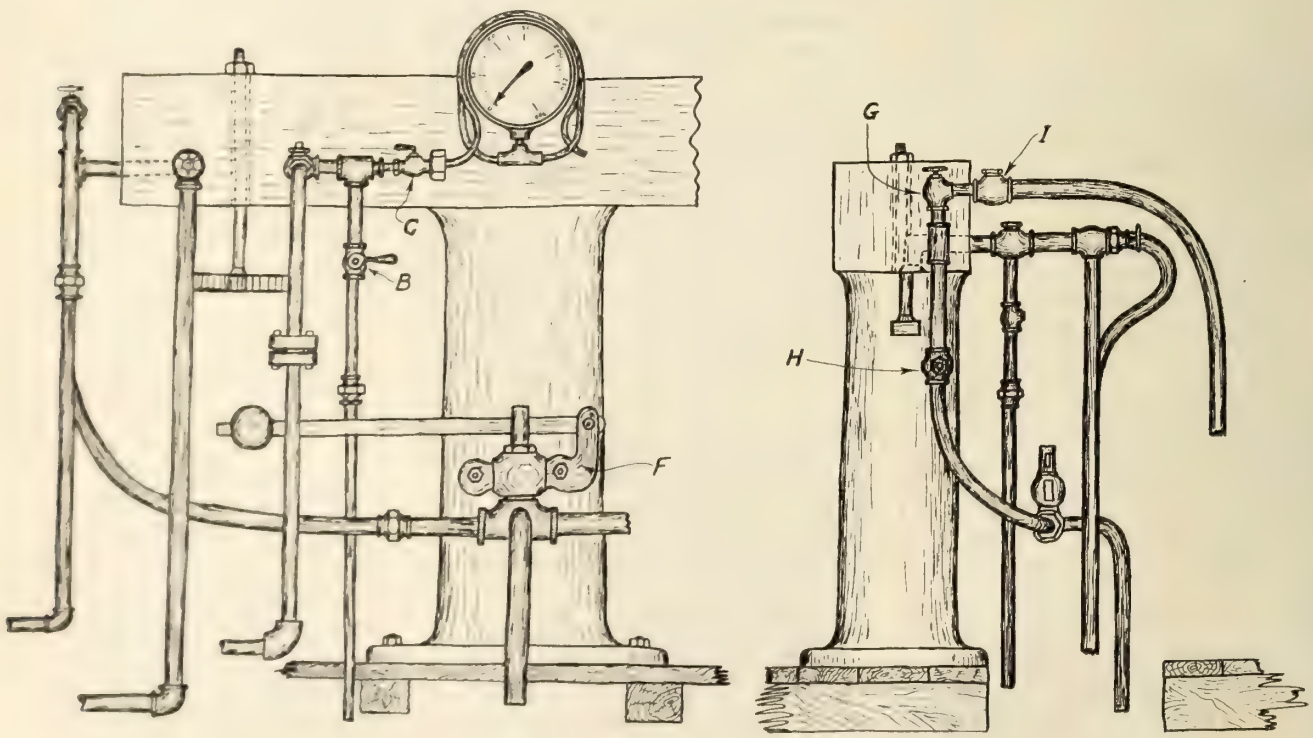
The gauge is connected to a "T" from which two leads run, one to each side of the apparatus. In each of these two lines of 5-16 inch copper tubing, a small lever operated valve is placed to enable the gauge to indicate pressures on either side of the testing apparatus. Between the ¾ inch city pressure supply line valve "A" and the header casting is a high pressure brass check valve, "D" (Fig. 3.) also the nipple between the check valve and the header is made from high pressure piping. This check valve "D" is to prevent injury to the low pressure lines in the event of the operator carelessly leaving the valve "A" open. It also prevents any wasting of water from the high pressure lines.

The gauge as before mentioned, indicates the pressure in the unit at the time the city supply is cut off. Next, the high pressure valve "E" (Fig.3.) is opened with a detachable handle which fits on the square extension of the valve stem, and water from this line at a pressure of 1,500 pounds per square inch is introduced into the unit through an opening 1-8 of an inch in diameter. The gauge slowly climbs until a pressure of from 250 pounds to 275 pounds per square inch is indicated. At a predetermined point the weighted relief valve "F" (Fig. 1) is set to open. Discharge from this valve goes into the pit, as shown in Fig. 1. Then the unit is examined all over for leaks. Next the high pressure water is shut off and the overflow valve "B" (Fig. 1.) opened. Following this compressed air is forced into the unit by opening valve "G" (Fig. 2.) ejecting all the water into the pit below.

The unit is then removed, and another inserted. Should a leak develop a welding outfit is used to weld the pipe on the spot and again the pipe is tested. The relief valve is connected to both sides of the apparatus, and by means of two valves it can be placed in the line of the side in use. One of these valves is shown at "H" (Fig. 2.) They are operated by the same detachable crank as operates the valve "E."

Check valves are also provided in the air line so that no water can accidentally be admitted to the air lines. One of these check valves is shown at "I". (Fig. 2.) Each side of the apparatus is provided with separate and independent air, high and low pressure water, and overflow lines, with independent operating valves. The gauge and relief valves only, are common to both sides. They are thrown over from one side to the other by means of valves as shown.

The high pressure line delivering water to the unit is ½ inch high pressure pipe. That is to say it takes ½ inch



Figs. 1 and 2, showing both the side and end view.

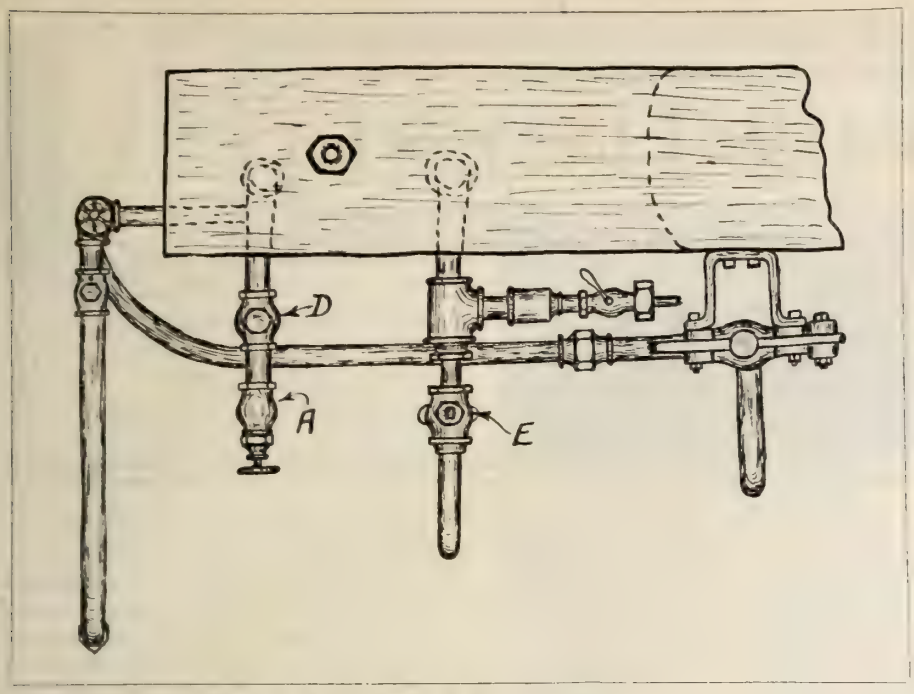


Fig. 3—A Plan View of the Apparatus.

fittings but the actual inside diameter of the pipe is about 5-16 of an inch. The lines leading to the relief valve are also ½ inch high pressure pipe. This permits of ample protection as the high pressure intake opening has been reduced to a diameter of ⅛ of an inch. Regarding this, it may be stated that a much smaller intake opening would be sufficient, but when using a smaller opening, say 1-32 of an inch, or 1-16 of an inch, difficulty is encountered with small bits of foreign matter in the water, clogging the opening.

The air line is ½ inch standard pipe, and the overflow line from valve "F" is ¾ inch pipe. Originally the seats in the "T" shaped header casting were spherical, in order that they fit the spherically ground ends of the units. These seats sometimes leaked and it was found that a 45 degree bevel seat, giving line contact gave practically perfect results.

C. A. S. E., MONTREAL NO. 1

On Dec. 23rd, Montreal No. 1 held an open meeting for the engineers and their friends.

Mr. Moore of the firm of Moore and Goldie, engineers and contractors, was in the chair. Brother Wright A. M. E. I. C., who is giving a series of lectures throughout the winter months on all branches of engineering, took for his subject, Boilers, Mechanical stokers, and Mechanical draft.

A lot of discussion arose as to mechanical versus natural draft plants, and their individual efficiencies and cost.

Brother Wrght then took the prime cost of various kinds of plants installed in Canada and the U. S. A., with the statistics of each, and proved to the satisfaction of his audience, that his assertions were based on prime cost, maintenance, depreciation and efficiency, according to the size of the different plants and their environments.

At the close of the meeting, a hearty vote of thanks was tendered the lecturer, who responded in an able manner, and stated that he was trying to gather the manufacturers together, with the cooperation of various members of the Engineering Institute of Canada, to take an interest in the C. A. S. E. as he thought that in years to come the C. A. S. E. could be of great assistance to them in their various enterprises, which according to "seers" would be of a magnitude more than usual.

QUICK PULLEY COMPUTATIONS

By W. F. Schaphoist

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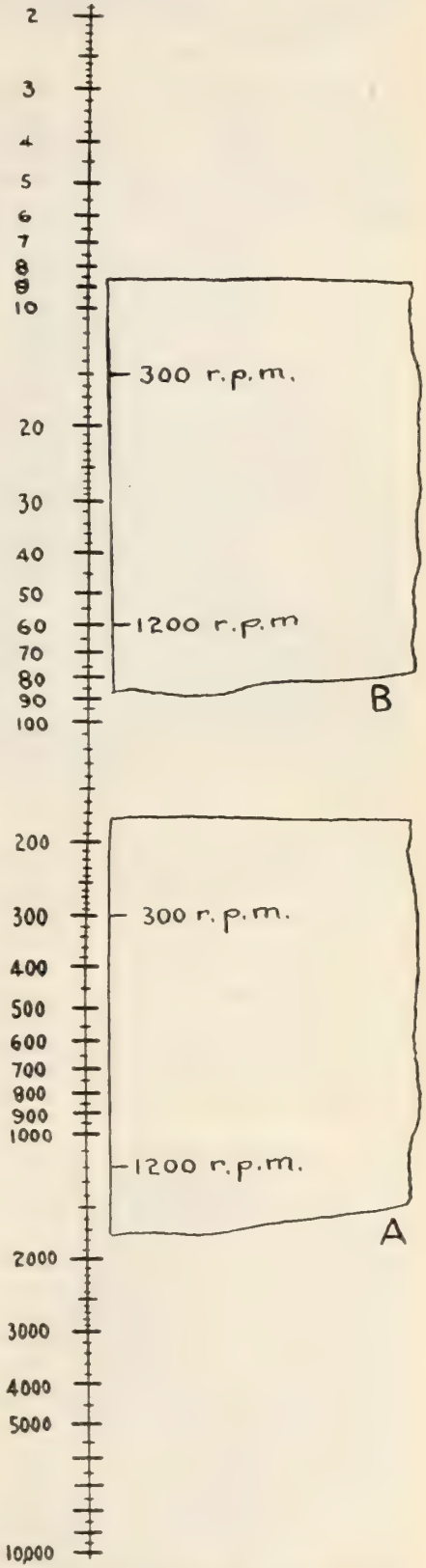
The simple chart shown does away with formulas for making pulley computations. It will be found to be exceedingly quick. Just slide the slip of paper from position "A" to position "B" and the problem is immediately solved.

For example:—A motor running 1200 r.p.m. is to drive a line shaft at 300 r.p.m. What sizes of pulleys should be used? On the slip of paper in portion "A" make marks opposite the 300 and the 1200 as I have done. That's all you need do; but if you want to write down "300 r.p.m." and "1,200 r.p.m." also, all right—it doesn't make any difference.

Then slide the slip of paper up to wherever you want it. Position "B" shows that pulleys 15 inches and 60 inches in diameter respectively will do the work very well.

If those diameters are considered too large just shove the slip a little higher and choose the best diameter. No matter where the slip is placed, the ratio is always correct—no figuring is necessary. The chart also lends itself readily to the solution of such a problem as —knowing the pulley diameters, and knowing the speed of one of the pulleys, what is the speed of the other pulley?



This chart could well be clipped out and pasted to a piece of cardboard for general use.

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POWER HOUSE

JANUARY 20th, 1922

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Freak Fuel Savers

FROM time to time there is offered to the public in general, and the engineering public in particular, some novel method of saving fuel which claims to be able to perform a revolution in all established practice.

Too often, these wonderful discoveries emanate from men but with little practical experience and even less theoretical, (technical is a better word,) knowledge. Their ideas are founded on a lack of fundamentals, so that the cold light of scientific fact turned upon them pierces the armor of verbiage in which they are clad, and exposes the skeleton underneath.

The principles of combustion are so well known, or they should be so well known, to all who are interested in the generation of steam by means of oil or coal fuel, that it is difficult to see how these earnest, if misguided, people are able to deceive themselves so thoroughly as to deceive others who have not had the opportunity to become acquainted with these principles. They do so, however, and very often succeed in convincing otherwise hard-headed business men that they have discovered a sort of elixir of life as far as fuel is concerned.

Their claims are as a rule so exaggerated that their nature should draw suspicion on the proposition as soon as it is mooted. A saving of at least 25 per cent. is spoken of glibly, and in some cases the saving is claimed to be 50 per cent. When it is considered that with the very best appliances, developed over years of intensive study by scientists and manufacturers, with the help of practical experience in large units, an efficiency of 70 to 75 per cent. in ordinary practice is considered very good, it is difficult to see how anyone can come along and make a saving of 25 to 50 per cent. at one jump.

There is no doubt that in the ordinary plant, a considerable saving can be made, which may be anywhere from 5 per cent. to 15 per cent., but this could be made without the help of any special apparatus. The exclusion of infiltrating air through the setting, attention to brick work, the correct spacing of fire bars, and a proper attention to draft, will work wonders in the ordinary plant which is running along on the principle of merely throwing so much coal in the fire per hour.

Any competent engineer with a draft gauge and a hand flue gas analyzer could make such an improvement in the average plant that the owner would sit up and rub his eyes when he saw the results.

We would advise power plant owners, and engineers, and anyone else who is running a steam boiler, to look with considerable suspicion on any philanthropist who wants for a consideration to instal something under his boiler that will cut down his fuel bill from 25 to 50 per cent. If he feels that the thing has merit, then he may allow the vendor to put a trial installation under his boiler, the owner protecting himself by demanding proper guarantees from the vendor.

A test carried out under the supervision of a recognised authority in the engineering profession, under proper conditions, which will give the evaporation per lb. coal accurately will demonstrate immediately whether there is any truth in the claims made. Even then, the owner should take the precaution to have his boiler put into ordinary decent shape before he has the first test made, so that he can see what his boiler should do under ordinary conditions without the aid of the special apparatus, so that he is not comparing working under special conditions with working under subnormal conditions.

There is no mystery about combustion of fuel in a boiler furnace, and anyone who can devise a method that will ensure a saving of 5 per cent. from the consumption in a plant that is working at 70 to 75 per cent. efficiency, will not have to search the highways and byways for customers. That is, of course, if the cost of saving does not exceed the saving itself.

Any man who can really and truly build a furnace or devise any apparatus that will make a marked saving in the consumption of fuel for a given evaporation will be performing a valuable service to his country, as well as enriching himself. All the work of the best brains in Europe and on this continent have so far only succeeded in bringing the efficiency of fuel burned under boilers in the very best examples of modern practice to an average of 70 per cent.

If a boiler is working under ordinary conditions at an efficiency of 50 per cent., then half the fuel is being wasted. If someone comes along and claims to be able to save 50 per cent. of the fuel, then he is making the boiler 75 per cent. efficient. If, however, he claims to be able to increase the efficiency 50 per cent., he is making the boiler 100 per cent. efficient, which, as Euclid would say, is absurd.

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Progress in New Equipment

A NEW TYPE OF FAN

Gardner C. Derry*

In 1916, an engineer of one of the large Power Companies in New York issued specifications calling for an induced draft fan which would at the same time act as a cinder separator. No quotations were received in answer to this request as there was nothing of the kind on the market. Mr. H. F. Hagen, Manager of the Research Department of the B. F. Sturtevant Company, became interested in this problem and started to develop something which would serve the purpose. He was experimenting with a paddle wheel fan, with the runner painted a bright red which was not completely dried. After the fan had been run for about two hours, it was noticed that the driving sides of the tees, rivets, and the inlet portions of the blades were coated with a fine dust. It immediately occurred to Mr. Hagen that there was an action sufficiently strong to separate cinders from the flue gases. This fan had been run in a research laboratory where the air was not polluted with any manufacturing process and any dust which was in suspension in the air would be similar to that found in an office room. If a separation of such extremely fine dust was secured it seemed certain that the action would be successful with the very much heavier cinders.

The idea was then developed to provide buckets at the inlet edges of the blades of the paddle wheel fan. There remained only the problem of disposing of the dust which was caught and separated by the wheel. This proved an easy matter to do as inclined channels were provided leading out into the special dust chambers in the fan in which the dust could settle. Since it was impossible to blow the dust with air, as this would involve again a separation problem, it was decided to permit the dust to settle and fall by gravity into these dust chambers. These dust chambers lead to closed hoppers in which the dust is separated and from which it can be removed periodically or continuously by menas of screw or other conveyors. From the cut shown here, it is easy to see the action of the dust in entering the inclined channels and thence to the dust chambers. Several little guiding vanes will be noticed which serve to direct the air and cinders into the inclined channels.

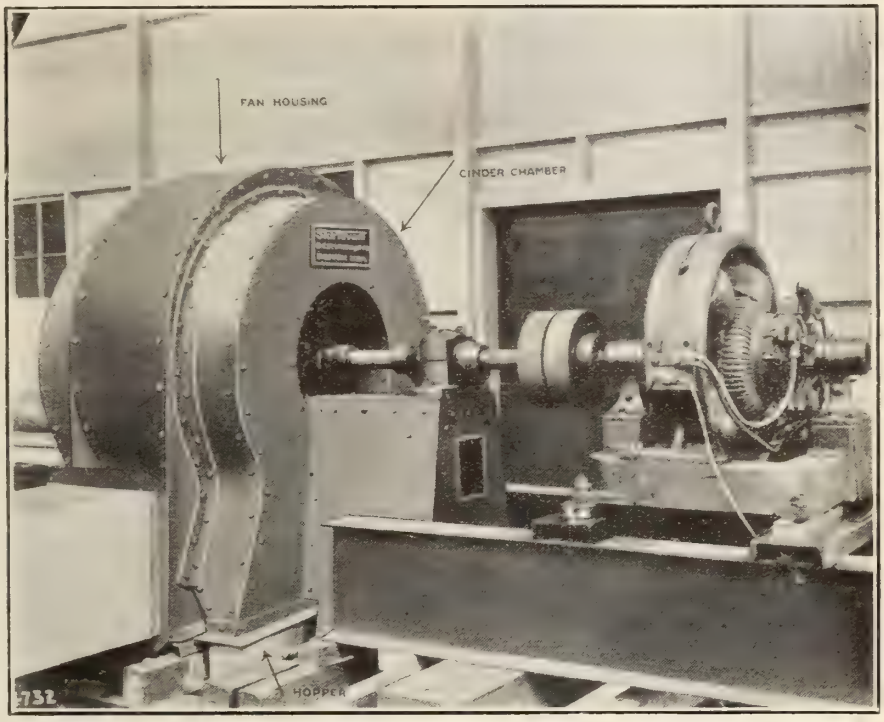
It was found that this cinder separating fan could be built without taking up any more room and without requiring any more attention than an ordinary induced draft fan. As a fan it proved more efficient than the average induced draft fan in the market and as a separator it was found, on test, to remove 75% of the solid matter in the gases. Naturally the fan removes a much larger percentage than this of the heavy, coarse material but it is this heavy, coarse material which drops over the city in the neighborhood of the power plants causing numerous complaints from the residents in that section.

Two large fans were installed in a large power plant in New York City and proved to be a complete success. These fans are installed in connection with six 500 H.P. boilers and when these boilers were operating at 200% of rating it was found that each fan was removing 250 lbs. of cinders per hour. At higher ratings this would be much greater and it was estimated that if these fans were placed on all of the boilers they would separate seven tons of cinders an hour.

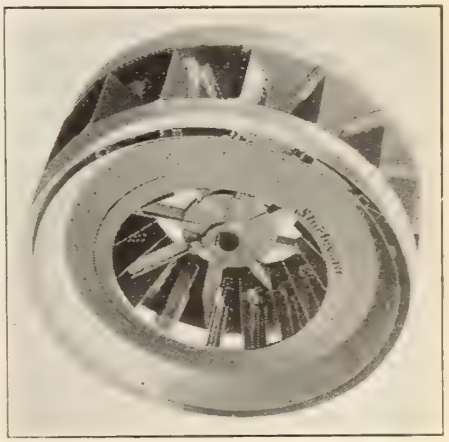
As a passing matter of interest, the material separated at this plant resembled a fine coke breeze and showed on analysis some 9,700 B. T. U. per pound.

The maintenance of these fans is practically negligible. The wheel will last as long as the wheel of an ordinary induced draft fan because the latter is subject to the same abrasive action caused by the cinders against the blades. The housing of the fan will last longer because a part of the cinders never reach the fan housing. The only place where there is any wear is in the cinder chamber of the fan housing. These cinder chambers are provided with easily removable strips of simple forms.

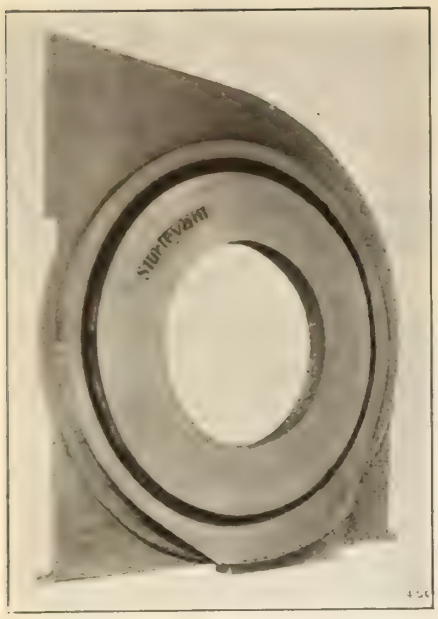
*Manager Fuel Economizer and Mechanical Draft Department of the B. F. Sturtevant Company, Hyde Park, Mass.



General arrangement fan with motor drive.



Showing dust channels



View of Casing.

The cinder-eliminating-induced draft fan is particularly desirable for use with underfeed stokers. The underfeed stokers do not cause a serious smoke nuisance, as we usually consider smoke, but when they are operating the boilers at overratings, the necessary high, forced draft pressure blows a lot of the finer portions of the coal over into the stack and these are carried up and discharged over the city. The nuisance thus produced is very serious and is getting more so as boilers are being forced to higher and higher ratings. The extremely fine particles in the smoke are not particularly objectionable because they are carried away by the air currents and are not deposited over the surrounding neighborhood, but the dust and cinders in the gases are fairly heavy and fall within comparatively short distance of the stack.

Many attempts have been made to clean the gases from boilers but the success that has been attained up to the present time has not been sufficient to warrant a general installation of dust removing devices. Usually an electrical system is an expensive proposition to operate and involves a high investment. The washing of the gases, as sometimes resorted to has given fairly good separation but the high up-keep of the washers and flue work makes this method of solving the problem very objectionable. The gases coming in contact with the water form a corrosive unless some non-corrosive material is installed which usually is an expensive undertaking. Another serious difficulty in the above method was that it killed the draft and in some cases it became necessary to by-pass the washer at the higher overloads in order to secure the necessary draft. It is thus seen that the installation when it is needed most requires a fan to supply the draft which is already taken care of in the case of the cinder eliminating fan.

It is readily seen from the above that this fan can be adopted to collect many other kinds of materials. The B. F. Sturtevant Company maintain an experimental fan in their Research Laboratory which is used constantly for trying out new materials which their customers send to them.

In this way they are able to determine the amount of separation that is possible to secure from the fan and also to accurately design the proper size fan for each particular problem which they have to meet.

These fans have been installed in New York City, Rochester, N. Y., Trenton, N. J., Salem, Mass., Fitchburg, Mass., on cinder elimination and they also have the fan operating successfully in connection with boilers using pulverized fuel at the British Columbia Sugar Refining Co. at Vancouver, B. C., besides many of the smaller fans used in the various industries for separating dust from fumes in their various processes.

ELECTRIC HOIST

The Shepard Electric Crane and Hoist Co., of Montour Falls, N. Y. have recently placed on the market an electric hoist. The crane is designed to operate on an overhead runway and can be easily attached to a standard "I" section of the proper size. A fully enclosed motor is furnished with interchangeable frames for direct and alternating current. The motor was especially designed and developed for hoist work, it being carefully insulated and impregnated to protect it from moisture.

The direct current motor is of the standard, series wound, interpole type. The no load speed is twice that of the full load speed, so that a light hook is handled twice as quickly as a full load. The induction motor furnished for alternating current may be either the squirrel-cage or the slip-ring type. The squirrel-cage motor is used with the single speed control and the slip ring type with the variable speed control. As just mentioned, single speed and variable speed controllers can be furnished for either type of motor. The direct current variable speed controller gives from eleven to thirteen speed changes according to the size of the motor. When alternating current is used eight running speeds are available. The controllers, like the motors, are readily accessible although fully enclosed and well protected against dust and moisture. All parts of the mechanism, including the resistance, can be removed without disconnecting a single wire. The contacts and brushes can also be removed without disturbing other parts of the controller. A mechanical brake of the multiple disc type is provided, the function of which is to automatically hold the load when the motor is at rest. It also prevents excessive speed when lowering. An electric brake of the multiple disc type brings the motor promptly to rest when the current is cut off intentionally or otherwise. An automatic limit switch prevents overrunning of the load hook.

ANNOUNCEMENT

Mr. W. O. Renkin has become associated with the Hardinge Company, Incorporated, 120 Broadway, New York, N. Y., in the capacity of Managing Engineer of the Quigley Pulverized Fuel Department, since this department of the Quigley Furnase Specialties Co. has been acquired by the Hardinge Company, Incorporated.

We are informed that Mr. George Farrow, Mount Dennis, Ontario, has been appointed representative and demonstrator in Ontario of the Wm. B. Pierce Co., Buffalo, N. Y., handling the Dean boilertube cleaner.

Mr. O. M. Rau, formerly Consulting Engineer to the Philadelphia Rapid Transit Co., has now become associated with the Hardinge Company, Incorporated, 120 Broadway, New York, N. Y., and will specialize in the handling of Quigley Pulverized Fuel Systems as applied to boilers. This change took place with the acquirement by the Hardinge Company, Incorporated, of the Pulverized Fuel Department of the Quigley Furnace Specialities Co.

NEW BOOKS

We have received a catalogue from Theo, Audel & Co., describing their new set of books for engineers and mechanics. This set has been named by the publishers the "Master Set," and consists of twelve volumes covering the usual subjects appertaining to stationary and marine engineering, and a volume on gas and oil engines.

LARGE CRANK SHAFT

Something approaching a record in large crank shafts was recently achieved in a British engineering works. This shaft was constructed for a large marine engine. It measures nearly forty-three feet long and weighs fifty tons. Much more notable than its size, however, was the accuracy with which it was finished When the shaft was inspected the error in the total length was only eight one-thousandths of an inch, while the maximum error in all the bearings did not exceed twelve ten-thousandths of an inch.

SIMPLE HYDROHOIST

One of the simplest forms of pump consists of an endless chain in the links of which, owing to their peculiar shape, the water is trapped and raised. The mechanism, in fact, operates as a water hoist. In order to make it more efficient a British firm has introduced a very ingenious modification. A wire rope is used, and on this rope are threaded a series of small steel cups, each with a thimble at its centre to keep it at the right distance from its neighbors. When the rope runs at 600 feet per minute this hoist will deliver 3,500 gallons per hour. Curiously enough this delivery represents more than a solid column of water of the diameter of the cups. The cups rise full of water, and there is in addition a large quantity carried on the outside.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

TESTING OF OIL

Question:—Could you tell me through your columns of some method of testing oils and the apparatus necessary for this purpose?

Answer:—Tests for the quality of oil can be made only on proper instruments to be of real use. These tests are for viscosity, flash point, and firepoint. The viscosity tests are made on instruments called viscosimeters, and the principle is the time required for a definite quantity of oil, usually measured in cubic centimetres, to pass through a known orifice while at a certain temperature. The chief of these instruments are the Saybolt, the Engler, and the Redwood. These are commercial instruments, and while they do not give laboratory accuracy, are sufficiently accurate to make comparisons of different oils with each other and with water. Sterling's handbook says: "The proper viscosity for a motor oil is determined by the piston ring clearance and the conditions of the rings and the cylinder walls. A wide clearance or worn rings, either of which cause poor compression, requires a high viscosity oil in order to secure the best results. If the piston rings are closely fitted to the walls a light-bodied oil should be used. If too light an oil is used, too much oil will get past the piston rings on the suction stroke, and, on the compression strokes of the fuel mixture, will leak past the piston rings and condense in the crank case, reducing the viscosity of the oil. If the oil is too viscous there will be a loss of power. Good compression depends very largely on proper lubrication."

It seems that the only proper way to get a cylinder lubricating oil is to experiment till you find the one best suited to your particular case.

The flash point of oil is found by heating a quantity of oil in an open or closed cup, and determining the temperature at which the vapor coming from the oil can be ignited. The closed cup method is said to be the better of the two. The fire point is the temperature at which the vapor can be ignited and remain burning, while the flash point is that at which the vapor ignites and goes out again. Authorities state that the flash point of an internal lubricating oil for a motor has little importance in practice. All motor oils have a flash point that is above that necessary for the purpose they are used for.

OIL IN BOILERS

Question:—I am in charge of a heating plant with two 16 feet by 66 inch dia. boilers and one 12 feet by 48 inch boiler. The two large boilers are used for heating, and are fed from the returns. The boilers carry about 30 lbs. pressure. We use three pumps which exhaust through an oil separator into the heating system. Would an occasional dose of soda overcome the oil before it would drop to the boiler plate? Is there a mineral cylinder oil on the market that would not injure a boiler if it did get into it?

Answer:—The safest way to deal with oil is to prevent it getting into the boiler in the first place, as after it once gets in, it is very difficult to deal with it by means of chemical action. With an efficient oil separator and a reasonable amount of oil in use there should be no oil getting into the boiler at all. If there is an open heater in use, the presence of oil should be detected floating on the water in the gauge glass of the heater, and thus give warning. One means of dealing with oil in the boiler is to blow it off through a surface blow-off, which is an easy thing to install in a H. R. T. boiler. Any oil that gets into a boiler is dangerous. If the oil separator is not efficient, a good filter will do the trick. There are a number of these on the market, or they can be made with the help of a perforated plate and some Turkish toweling or cheese cloth.

HORSE POWER OF GAS ENGINE

Question:—How can I find the horsepower of a three cylinder gas engine, 12 inches dia. x 18 inches stroke, 240 R.P.M.?

Answer:—The horse power of a gas engine can be found from the formula

$$\frac{P \times L \times A \times N}{33000}$$

where P is the pressure per square inch on the piston, L is the length of stroke in feet, A is the area of the piston, and N the number of strokes per minute. The horse power will depend on whether the engine is of the two-cycle or four-cycle. If a two-cycle there will be a working stroke every revolution, while the four-cycle only has a working stroke every two revolutions. The average mean effective pressure is about 70 lbs. per square inch so that if your engine is a two-cycle the formula would be

$$\frac{P \times L \times A \times N}{2x33000}$$

and if a four cycle

$$\frac{P \times L \times A \times N}{4x33000}$$

With a diameter of 16 inches the area of piston would be 16x16x7854 and the stroke 1.5. Then

$$\frac{70x1.5x201.06x480}{2x33000} = \text{I.H.P.}$$

for two-cycle and

$$\frac{70x1.5x201.06x480}{4x33000} = \text{I.H.P.}$$

for a four-cycle on each cylinder. This would give for two-cycle 153.5x3=460.5, on three cylinders, and for four cycle 230.25 on three cylinders.

DIAMETER OF SHAFTING

Question:—Would you please figure out for me in your "Question Box" what size of shaft is required for a stationary engine having an overhung crank. Size of cylinder 14 inches, stroke,14 inches. Revolutions 195 per minute. Boiler Pressure 110 lbs. per sq. inch.

Answer:—For the diameter of an overhung crank shaft, which differs from a shaft having two bearings by the fact that there is a bending moment as well as a twisting moment, an approximate formula is diameter equals .4 x dia. of cylinder. Using this formula the diameter is

14 x .4=5.6 inches.

In order to get an absolutely accurate estimate, a great many more particulars would have to be known. However this formula has been arrived at by plotting curves from the diameters of six different engines in which the combined twisting and bending moment has been fully worked out, and found to follow very closely a straight line law.

RATTLING IN CYLINDER

Question:—We have a 16-inch by 18-inch high speed engine running at 225 r.p.m. with 110 lbs. of steam. This engine when under load runs very quietly,

but when running light there is a very loud rattle in the cylinder. There are two rings on the piston, ⅝-inch by 1½-inch. The rings and cylinder appear to be in good condition. Would you kindly give me some information through Power House on the cause of this rattle in the cylinder?

Answer:—We take it that the engine is a fly-wheel governor type, as most of these engines are. It is not an unusual thing to hear a rattle in the cylinder of these engines when running light, and it is caused chiefly by the very early cut-off and high compression on the return stroke due to the automatic governor. This compression is at times high enough to cause a momentary lifting of the slide valve from its face, and the accompanying return causes a sound like a rattle. There is always a tendency to a little play in the piston rings due to the pressure behind the piston falling below the atmosphere when cut-off is very early and excessive cylinder condensation will also occur, which usually causes a cracking sound. Some of the rattle which seems to be in the cylinder may be in the guides, if there is any slack in them, and will be caused by the flywheel pulling the engine round during part of the stroke, and lifting the slipper against the top guide.

As long as your engine runs quietly when under full load, which we presume is the normal way of running, a little rattle at light loads is not a very serious matter. Any slight slackness is more likely to show up when running light than when under a steady load.

EFFECT OF HIGH ALTITUDE

Question:—Will you please explain why a semi-Diesel engine will develop more power at the sea level than at a higher altitude? Is it because there is more moisture in the air or because a greater volume of air enters the combustion chamber by reason of greater atmospheric pressure? When purchasing my plant two years ago the makers informed me that it would develop 25 horse power at sea level but at an altitude 2,000 feet above that, I would lose about 3.4 horse power. Under actual running conditions last winter I found that with a load of 115 volts and 120 amperes she would choke herself and stop. This happened on several occasions and I was at a loss for a reason because this is only 13.8 K. W. I later installed a water injection (which is strictly against the rules) with the result that I can now develop 125 volts and 16 amperes with ease.

Before installing the water feed she would pound like everything as soon as the load began to come up around 110 amperes, but now she is as silent as any steam engine with a far bigger load. I would like to hear from some of our fellow-operators as to their opinion and experiences in this line.

There are several engineers in this district, one of them a graduate of Manitoba Agricultural College, who laugh at the idea of water injection, but I can show them where it works on my outfit.

Answer:—The cause of internal combustion engine developing less power at a high altitude is because of the rarefied atmosphere prevailing at that point. This leads to a lesser weight of air per cubic foot, and the volume of the cylinder remaining constant, the weight of air pressure stroke and the compression pressure is lowered, thus leading to lower powers. This has been especially noticeable in airplane engines reaching great heights, and to overcome it, supercharging has been resorted to. This is simply a means of compressing the air before its admission to the cylinder, thus counterbalancing the lesser density at the high altitude.

Water injection has been used on gasoline and oil engines with success at various times, and there is no doubt that it has a beneficial effect in cooling the piston head and cylinder walls. In this way it lessens the chances of pre-ignition and the deposit of carbon, and tends to a smoother working engine. It has been objected to as being an unnecessary complication, and as having a tendency to cause corrosion. Used in the small quantities that are required there is not much danger from this cause.

The heavy pounding noticed by you previously was no doubt due to pre-ignition, which would be caused by hot carbon deposits on piston head. These deposits were no doubt caused in the first place by incomplete combustion due to the poor mixture of air. Pre-ignition would lead to more incomplete combustion and more deposit so that the remedy applied by you in the water injection, undoubtedly had a good effect. The evaporation of the water into steam would have a considerable cooling effect, and the steam generated would have a good effect on the compression.

It does not seem to us that there is much to laugh at, especially as you have proven the benefit in your own particular case. What do the builders say?

A BOILER SCALE PARADOX?

By W. F. Schaphurst

Many engineers of much experience have never thought of this easily explained truth—that the boiler tubes that are cleanest scale the most. Sounds like a contradictory statement, doesn't it? Yet it is a fact. The catch that "gets 'em" is that the word "outside" is omitted. In other words, the tubes that are dirty with soot will not be so dirty inside, because soot is about as good an insulator as there is against the flow of heat. Authorities who should know declare that soot is a more effective insulator than asbestos, and that is "going some." To cause all boiler tubes to scale an equal amount in a given time, therefore, it behooves the operator of the soot cleaning machine to keep all tubes equally clean, from top to bottom. And even then, perhaps, there will be considerably more scale to be found in the bottom tubes where heat is most intense. The tube that absorbs the most heat will evaporate the most water, and therefore will leave the most scale to cling to and impair the heat transmitting qualities of the tube. Thus the boiler tube is "twixt the devil and the deep sea" in that it is beset on both sides by a substance that is injurious to the plant owner's pocket book, directly through the coal pile—soot on the outside and scale on the inside. If it is a fire tube boiler the reverse is the case.

This explains why it is that in many boilers scale in the tubes is thicker on one side of the tube bank than on the other. In such boilers it is invariably found that the soot is blown off the tubes through the dusting doors at the sides of the setting. The cleaning, however, is not THOROUGH enough because the boiler is not equipped with the proper kind of apparatus for regular cleaning. A hand lance thrust through the dusting doors does not clean the "far side" of the boiler. Instead of cleaning the tubes on the far side it blows the soot from the "near side" over onto the tubes farther away, and makes matters worse. In some cases it has been found that tubes have been packed completely full of soot, and they might just as well not have been in the boiler at all. By looking into the problem with care, and studying the cross section of a typical horizontal water tube boiler, it will be readily understood why and how it is possible for the tubes to become packed full of soot where hand lance blowers are constantly used.

The better way to clean off the soot is to install a permanent cleaner on top of the tube bank and blow down between the tubes. The soot is thus cleaned off from one side to the other in a uniform manner and instead of having the jets blow against the wall the jets blow the soot downward into the clean space below the tubes. It is impossible, in designs of this kind, for the tubes to become clogged full of soot. Scale formatin, also, will be uniform from side to side. It has been pointed out that during the scaling process some of the workmen may "think" that the scale is thicker on one side than on the other. The thickness, it is said, varies directly with the tiredness of the man. There may be some truth in that statement but it nevertheless does not alter the above.

It has also been said that much depends upon the way in which the fireman shove's coal into the furnace. If he is left-handed, he may throw more coal onto one side than the other and thus keep one side of the boiler hotter. There may be some truth in that, but the fact remains that the tubes that evaporate the most water or absorb the most heat are the ones that will have the thickest scale.

Practical Electricity for the Engineer

By G. R. ARCHDEACON, A.M.I.E.E.

Doubtless many of the readers of Power House are already asking themselves the well-worn question, "What is electricity?"

To be perfectly candid I do not know; but what is still more surprising is that I am unable to find any person who can give me this much-desired information. No one has ever heard, seen or tasted electricity. We see many effects of electricity, many results which follow the presence of electricity, but the thing itself remains to be actually discovered. Fortunately for mankind, it does not really matter whether we know what electricity is or not, for we have learned how to control it, and apply it to our daily needs.

Electricity And Magnetism

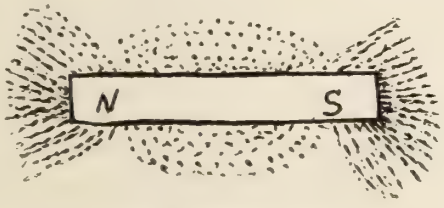
Before taking a wild leap into the intricate subject of the design of dynamos, alternators, motors, etc., it is desirable that we devote at least a portion of our time to the consideration of the various laws that appear to govern the production and distribution of electricity.

The old conundrum of "which came first, the chicken or the egg," may be applied to the study of electricity and magnetism and put this way, "which came first, electricity or magnetism." They are both as hard to answer. Magnetism develops electricity, and electricity develops magnetism, but which of the two came first does not seem to be known. It is therefore necessary that we consider briefly the underlying principles controlling the development of these two forces.

Magnets

Magnets are made of either iron or steel. In the case of the magnet made from iron, the property of magnetism is not permanent, as it is liable to lose its magnetism quickly, or in other words to become de-magnetized. On the other hand the steel magnet retains its magnetism almost indefinitely. Steel magnets are therefore generally termed "permanent magnets."

To produce a permanent magnet it is only necessary to take a piece of steel and rub it on one of the ends of a magnet several times, seeing that it is drawn across the magnet in one direction only. The steel mysteriously acquires this force of magnetism and may retain it for several years, and can be renewed at any time by repeating the above process.



Lines of Magnetic Force.

The magnet made from soft iron is usually an electro-magnet. It is made by winding a few turns of wire around the soft iron, and connecting it to a source of electricity with the result that it becomes magnetised. This magnetism is practically all lost when the electric current is disconnected.

The extremities of all magnets are known as the poles and are called the north pole and south pole respectively. The greatest force is always exerted by these poles, and the force diminishes towards the centre of the magnet. From each of these poles a force of magnetism is radiating in what is known as "lines of magnetic force" or the "magnetic field."

Any body near enough to be affected by the lines of magnetic force is said to be within the magnetic field. Instances of this are seen in the armature of a dynamo, alternator, motor or the trembler of an electric bell.

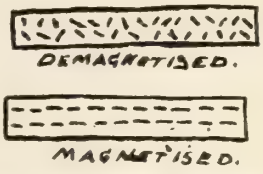
The value of this magnetic field is variable, in the case of a permanent magnet by increasing the area of the magnet pole, but in the case of the electro magnet by increasing the number of turns of wire around the magnet and increasing the quantity of electricity flowing in the wires. To demonstrate the effect of the "magetic field" take a sheet of paper, sprinkle evenly with iron filings, and note the position in which the filings fall. Now insert underneath the sheet of paper a magnet and you will immediately observe the iron filings take up a definite position around each of the poles of the magnet. Fig. 1.

Attraction and Repulsion

We are now in a position to appreciate the fact that a magnetic pole has the power of attracting certain bodies. We have yet to observe another phenomenon, and that it is its power to repel certain bodies.

Take an ordinary pocket compass, place it on a table, and place a bar magnet close to it, gradually pushing the magnet nearer the compass. Immediately the needle of the compass comes within the range of the magnetic field, one end of the compass will point directly toward the magnet, thus proving the power of attraction.

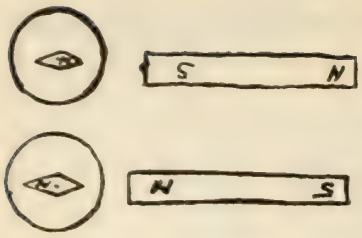
Now present the opposite end of the magnet to the compass, and the needle will be swung the other way, thus proving the power of repulsion. It is this



Effect of Magnetism on Molecules.

power of attraction and repulsion of magnets that makes possible the electric motor, as by mechanically presenting the north and south poles alternately we can cause rotation of a piece of iron placed in the magnetic field.

Magnetism is undoubtedly one of the most mysterious forces of nature. It is found in the form of magnetic iron



Effect of Polarity on Needle

ore in various parts of the world, and was known to the ancients as the lodestone.

One is struck with the remarkable nature of this force when reflecting that if a piece of steel is magnetised, it acquires a force it did not formerly possess, a force which is capable of actually lifting certain bodies. Yet if we carefully examine the steel before and after magnetising, we find in spite of the additional force, there is no increase in weight, or general dimensions, or chemical composition. The only change is in the molecular construction. Whereas before magnetising the molecules of steel were in a state of disorder, after magnetising they assume a regular form as of a company of soldiers on parade.

Magnetism, unlike electricity, is very difficult to insulate. This may be demonstrated by placing a needle on a table and moving a magnet along the underside of the table. Immediately the magnet approaches the needle it will be observed that the needle moves in an attempt to get closer to the magnet, exactly as if there were no table top intervening. This experiment may be repeated with various other materials, definitely proving the magnetic lines of force penetrate all such materials. This characteristic is the frequent source of inaccuracies in supply meters, and various delicate testing and measuring instruments used in the practical application of electricity.

We have already demonstrated that electricity develops magnetism, we have now to prove that magnetism develops electricity.

We are all familiar with the horseshoe magnet. This is only the ordinary bar magnet bent into the shape of a U. If we take a piece of wire and connect both ends to the terminal of a galvanometer, and move the wire up and down between the poles of the magnet, electricity will be developed in the wire, flow through the galvanometer, and cause the movable pointer on the galvanometer to oscillate.

This is precisely what occurs when we cause the armature of a dynamo to be rotated between the poles of the dynamo. Magnetic lines of force are radiating from the poles of the dynamo. The wire on the armature moves up and down cutting these lines of force and we have the electricity which flows on through the cables, to run the street car or to heat up the humble cup of coffee in the electric percolator.

From this demonstration we derive the law of magnets, "Unlike poles attract and like poles repel each other."

POINTERS ON ELECTRO-POWER RATES

By George MacLean

Three subjects that are frequently little understood among men who are responsible for the purchase of power for industrial plants are the flat rates, kilowatt-hours and maximum demand. A flat rate is based on the connected load. Assume an installation of several motors, amounting in all to 200 h.p. and a rate of $40 per horsepower year is charged. Then the cost of power per month is

$$\frac{40 \times 200}{12} = \$666.66$$ for the connected

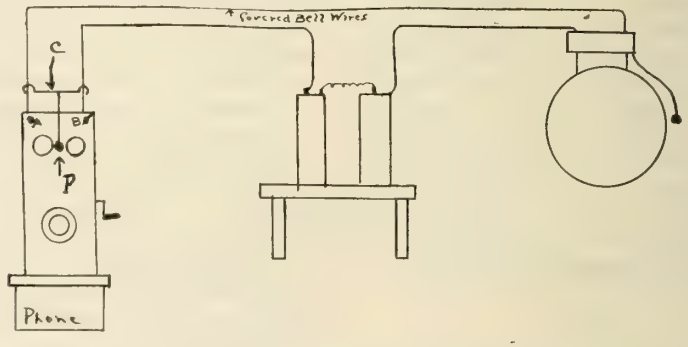
load of 200 h.p. The advantage or disadvantage of a rate of this kind depends on the load factor, or the ratio of the horsepower employed to the motor horsepower. From this it can be readily seen that if only 100 h.p. of the total connected load of 200 h.p. is being utilized, then the connected load factor is 50 per cent. or 50 per cent. of the connected load is being needlessly paid for and produces no return. Thus if the contract is on a flat-rate basis, watch the motors and keep them loaded up to full load, if possible. Also, the processes should be arranged so as to keep all motors in service as much as possible, for when they are stopped the power expense is still going on.

The kilowatt-hour is the equivalent of 1,000 watts for one hour, of $1,000 watt-hours. This method of buying power has the advantage over the flat-rate system, in that only the power used is paid for. If on 200-h.p. connected load only 100 kilowatt, or 134 h.p., is used continuously for one hour, the power consumed is 100 KW-HR. and this is what is paid for. The total 200 h.p. is not paid for, as on the flat rate, but only for the actual power consumed by the motors.

Maximum demand presents a different problem than either the flat-rate or kilowatt-hour rate. A special meter is connected in the circuit, which automatically registers the highest amount of power used over a certain interval of time. If you have contracted for 200 h.p. and the maximum demand does not exceed this, then only 200 h.p. is paid for. However, if the max. is 250 h.p., say for 15 minutes, for any one day during the month, then 250 h.p. is charged for. The reason for this is that the power company is supposed to have to hold in reserve sufficient capacity to meet the needs of the customer. Evidently much can be done to keep the peak loads down by the proper manipulation and arrangement of machinery. For example, if there are a number of heavy processes that operate only intermittently, then, if it is possible to have different processes going on at different times, the load will be much lower than if all were in operation at once.

The maximum demand rate can also be used in conjunction with a kilowatt-hour rate; that is, so much per kilowatt-hour is charged and in addition to this, so much per kilowatt maximum demand for a given interval during the month is also charged.

The output of coal from Canadian mines during the first nine months of 1921 was ten and three quarter million tons as compared with slightly over twelve million tons the corresponding period of 1920, according to a statement issued by the Dominion bureau of statistics. While the production was less than the previous year, it was greater than 1919, when the output of nine months period was 14 per cent less.



LOUD TELEPHONE BELLS

This loud ringing telephone call bell is so easy to install that anyone having use for such a bell should connect one. To make it, install a regular bell outfit, as batteries D and bell E, connect the end of the wires at A and B. Bend a piece of bare copper wire and fit it on the wires as at C. To set it place the end of the bare wire leg on the bell hammer at F. When the telephone rings the leg will fall off the hammer and allow the bare wire to fall onto the phone terminals at A B. This will cause the Bell E to ring until the leg is again raised and placed upon the telephone bell hammer.

The Operators' Point of View

EXCESS AIR AND EXIT GAS TEMPERATURE

Editor, Power House,

The question of heat losses is always an interesting one or at any rate it ought to be and anything that will increase our knowledge of how these losses occur will obviously be of value in enabling us to prevent them.

In "Power" of a recent date, H. D. Fisher in writing on "The Advantage of Nitrogen in the Boiler Furnace," incidentally gives us some information on the effect of excess air on exit gas temperature. He says:—

"It is a mistake to assume that an increased volume of gases will transmit heat to a boiler more efficiently, whether the entering temperature or entering total heat content of the gas is the same. In the first case, the temperature at the entrance being the same the rate of heat transfer. B. t. u. per square foot of heating surface per degree temperature difference per hour, does not increase as rapidly as the velocity, and the higher velocity gas will not be able to give up as much heat per square foot of heating surface passed over, and will therefore leave at a higher temperature, with correspondingly less efficiency.

"In the second case, the total heat content of the gases being the same, the larger volume of gas would be at a correspondingly lower temperature and give a lower rate of heat transfer resulting in a greater proportion of heat carried away by the higher velocity gases."

It will be noticed that Mr. Fisher does not give the "common explanation" given by Mr. Pratt and quoted in Power House of Nov. 21. He goes on to say, "This is shown experimentally, as I have analyzed flue gases from a 5000 sq. ft. hand-fired boiler equipped with flue gas temperature recorder and found that as the fire was changed from a very white hot fire giving 14 to 15 per cent. CO_2 with 0.3 to 1.0 per cent. CO with a flue gas temperature of 490 to 520 degrees, to a redder, cooler fire giving 10 to 11 per cent. CO_2 with no unburned gas, the flue temperature rose to 700 degrees F., the boiler being operated at 125 to 150 per cent. rating. Also in connection with some coal tests on a 5080 sq. ft. water tube boiler with mechanical stoker the following averages were obtained for 10 hours:

	Percentage rating	Developed
	116	109
Flue Gas temp. deg. F	541	586
CO_2 per cent.	10.4	8.9
Oxygen per cent.	9.0	11.3
CO per cent.	0.6	0.1
Nitrogen per cent.	80.0	79.7
Excess air per cent.	76	119

We see from this that a very white hot fire has a tendency to produce high CO_2 and a low temperature fire the reverse.

With 14 per cent. CO_2 the excess air

$$=\frac{20.7-14\times100}{14}=48\% \text{ nearly}$$

With 10 per cent. CO_2 the excess air

$$=\frac{20.7-10\times100}{10}=107\%$$

In addition to the above at the recent meeting of the A. S. M. E., Victor J. Azbe, reported the following tests A, B, and C, in which the effect of excess air is clearly seen.

	A.	B.	C.
Draft drop through fire, in...	3.45	3.76	4.05
Heating value of dry coal, B. t. u.	12,080	12,850	11,864
Per cent. rated capacity developed	102	140	185
Feed water temperature, deg. F.	180.6	187.0	176.8
Steam pressure, gauge, lb...	130	127	129
Temperature of flue gas, deg. F.	612	533	532
Per cent. CO2	7.6	13.3	14.0
Over all efficiency	56.0	68.5	78.1

The excess air in the above tests would be respectively
172% 48.1 48 nearly.

It will be noticed also that although the per cent. rated capacity developed was increased greatly from 102 to 185 the reduction in the excess air lowered the exit gas temperatures from 612° F to 532°.

With these concrete examples given it will be easier to believe the theory expressed in Power House of Nov. 21.

R. MacLaren,
160 Dovercourt Road
Toronto.

TREATMENT OF FEED WATER

Editor, Power House:

In your September 5th, 1921, issue of "Power House," we note article entitled "The Treatment of Boiler Feed Water" by Robert June. In paragraph headed "Boiler Metal Treatment" and referring particularly to Perolin, statement is made that it works its way along the steel, eventually forming an "insulating coating" between the scale and the tube.

We believe that this statement should be corrected, in that it gives an impression that the Perolin forms a coating on the tube, which interferes with transfer of heat, as this is the usual interpretation of the word insulating. We are inclined to believe that the author intended to bring out the fact that the coating prevented the adherence of scale to the tube, but as given in the article, it certainly leads to an erroneous and harmful conclusion.

Very truly years,
The Perolin Company of America,
By E. L. Gross, Vice-President.

C. A. S. E.

The Editor, Power House

I notice in your issue of Dec. 20th, a report of meeting Toronto No. 1. I am very pleased to read of the enthusiastic manner in which they are taking up the Grand Lodge Educational Matter, but one item is in error, viz; that no text books are allowed. I was instrumental in drawing up the rules of this competition and I don't remember any such clause. One rule stated that no magazine editor or magazine could take part in the competition.

Now, as the first set of questions are printed on this page, I would like to ask you, are these Toronto No. 1 own answers, or are they the answers of the magazine? If they are the magazine's own property, I would suggest that the answers be given a wider scope. Of couse, this will be left to the discretion of the examiner in his remarks to the Grand Secretary, and awarding of points.

In my letters to the various lodges I have suggested that formulae could be interspersed with the answers, to impress more fully, the points in question on the minds of those taking part in the contest. On first reading I was rather annoyed at the answers being printed, as some lodges may not have answered it in the form printed, these may become disheartened and take no further interest in the competition. However, after mature consideration, I think this could be put to a better purpose by saying that your answers could be more fully demonstrated, so that at the end of the competition, a good manuscript would be available in the lodge library.

I hope you will see your way to print this, in order that the error may be cleared up.

Yours truly,
Henry Wright,
Vice-President,
& Executive Committee.

Editor's Note.

The questions and answers referred to are published exactly as received from the secretary of the Lodge, and this journal has nothing more to do with them than extending the courtesy of publishing both questions and answers by request of the C. A. S. E. Toronto No. 1 Lodge. The introduction to the article distinctly states that the questions and answers were those submitted at the meeting of the Lodge.

Editor, Power House:—

Educational Contest C. A. S. E.

The following is an Exact Copy of the Rules, governing same, which was sent out to all Subordinate Lodges of the C. A. S. E. by the Grand Lodge Secretary, L. J. Ellis of date Nov. 11, 1921.

Rule No. 1—"Each Lodge to demonstrate in open meeting."

Rule No. 2—"No Lodge to ask information regarding the questions, from any Mechanical or Engineering Journal."

Rule No. 3—"The Secretary will take a copy of the answers (given) and record them in the minute book, he will also send a copy to the Grand Lodge Secretary written on plain paper without any marks or other means of identification. The Grand Secretary will allot each Lodge a number, which he will stamp on the first (copy of answers made) before sending it to the Examiner."

Rule No. 4—"Each set of questions to be sent to the Grand Secretary on the date stamped on the list."

Rule No. 5—"Any Lodge breaking these rules to be disqualified. Bro Ellis to be the final arbiter."

(Signed)
H. Wright
J. J. Sullivan

DOMINION CERTIFICATE

Editor, Power House:—

Having received the last edition of Power House I see by its columns that the discussion on the Dominion Wide Certificate for Stationary engineers is waxing rather warm and I also notice that I come in for my share as well. I wish to say that I had not any intention of finding any fault with my fellow engineers, but rather with the system under which the certificates in Ontario had been granted previous to the coming of the graded certificate. This has started engineering in Ontario on the road to the goal of better engineers and to placing engineers of this province on a par with their fellow engineers of other provinces, where certificates are won by the intelligence of the man writing the examination, instead of having the certificate donated to him. I am sorry that my friend Mr. Wright has taken it that I was finding fault with the engineers. Far from it. If a man asks for a certificate and it is granted him he is not at fault, it is the person or persons who issued the certificate. I only hope that every engineer in this broad Dominion will look into the matter of the Dominion Wide Certificate and lend his efforts to bring it about.

Hoping I have made myself clear re. my position to my fellow engineers, I have the honor to be,

Yours truly,
Frank Moore,
Sarnia.

The Editor.
"Power House:"

The letters in Power House under the heading "Dominion Wide Certificates," are very interesting to me and also to other engineers of my acquaintance, but the Ontario certificate seems to be only a license to take charge of a steam plant for one year. Why should an engineer have to pay one or two dollars every year to protect other people's property? It is a miserably paid profession and a man must keep up-to-date by subscribing to technical journals so that he may take advantage of other people's experience and it takes all a man can afford to keep up. The mention of Doctors in Henry Wright's letter (5th Jan.) makes me think of efficiency. If the average engineer gave no more efficient service than some of the doctors he would soon be let out.

The hot eccentric strap in J. W. C.'s letter (5th Jan.), I should have slowed down and brought it back with oil, but maybe they had a crabby old captain who couldn't be reasoned with. I was with a very clever chief who took the same course with a hot strap, he played the hose on lightly, and a liberal application of oil and escaped without damage, the ship was in danger and couldn't be stopped. If all who are interested in Dominion Wide Certificates write to you, you will need to enlarge your journal considerably.

Robert Gascoigne

The Editor,
"Power House:"

I note with much interest your letters on Dominion Wide Certificate in Nov. 5 and Dec. 5th issues of Power House. It is a matter that should interest every engineer in Canada and now that you have started the ball rolling I would like to see every engineer take hold and if possible get Canadian certificates and not Provincial. Why should an engineer who is a Canadian or British subject capable of passing an examination of a certain standard and proving his qualification, and is operating or has charge of a plant in Nova Scotia, not be capable of running the same plant in B. C., Ontario or any other province?

While I hold the certificate and the position of a first-class engineer in Ontario, yet I think that any engineer who has passed an examination of the same standard as I have should be entitled to operate in Ontario no matter where he passed his examination. I think Mr. Goepel's arguments against the subject could be easily overcome. Our hoisting engineers' examination will thoroughly overcome the logging difficulties of which he speaks, and is entirely separate and independent of stationary engineering. It is also a difficult examination to pass for any one who is not familiar with the operation of hoisting equipment. Any engineer who can handle locomotive cranes, hoists, etc., in Ontario, would be able to handle logging equipment in B. C.

Mr. Goepel also seems to think that B. C. has the strictest examinations and examiners in Canada, but I want to tell him that if they are any more difficult than our first-class exam, then nobody will get them but university graduates. Our examiners are fair and impartial, and you have to qualify for the grade you want.

I would say "Let us have Dominion Wide Certificates."

C. J. Morrisson,
Walkerville.

STEAM PIPE EXPLOSION FROM WATER HAMMER ACTION

The Board of Trade have issued, under the provisions of the Boiler Explosions Acts, 1882 and 1890, a report of a preliminary inquiry made by I. F. Blenkinsop, one of their surveyors, with regard to the circumstances and cause of a steam explosion which occurred on August 25, 1920, at the New Hall-lane Mill, Preston, in the occupation of Messrs. Paul Catterall, Son and Co., (1920) Limited. Fortunately no fatal result ensued, but one man was somewhat scalded.

The pipes, which were new, having been made by Messrs. John Spencer, Limited, Globe Tube Works, Wednesbury, the previous March, formed part of the main steam line leading to a new engine which had recently been installed at the mill. The steam line was made up of a number of lap-welded steel pipes, 9-in. internal diameter, 5/16 in. thick, with screwed-on flanges, 16-in. diameter, jointed together by twelve ⅞-in. bolts, having a pitch circle 14-in. in diameter. The mean distance from the boiler-house to the engine stop valve was about 80 ft., but with the several horizontal and vertical leads, the total length of steam pipe used was approximately 146 ft., Hydraulic tests were witnessed on the pipes to a pressure of 280 lb. per square inch by an inspector of the Vulcan Boiler and General Insurance Company, Limited, at the maker's works, in March 1920. At the time of the explosion, the new engine, boilers and economzers were insured by this

company, but the steam pipes were not covered by the policy.

Two lengths of steam pipe in the engine house were damaged by the explosion; one contained a longitudinal crack at the weld, open at its widest part, ½ in., and 9 in. in length, and the other a ragged hole, 7 in. from the weld, which had a maximum width of opening of 4 in., allowing steam and water to escape into the engine-house; the pressure of steam being about 140 lb. per square inch.

The explosion was due to water hammer action.

In his report to the Board of Trade, under the heading of "General Remarks," Mr. Blenkinsop writes as follows:

"The work carried on at the New Hall-Lane Mill is cotton spinning. Steam is supplied by three Lancashire boilers, each 30 ft. in length, by 8 ft. 6 in. in diameter, at a pressure of 180 lb. per square inch, and conveyed to the engine by a long range of lap-welded steel steam pipes, 9 in. in diameter. Before steam reaches the engine stop-valve it passes through a separator, to which is connected a steam trap, suitable for a pressure of 180 lb. per square inch. The power is distributed to the mill by means of rope gearing. A new engine built by Messrs. Yates and Thom, Blackburn, was recently installed, when new steam and feed pipes were fitted; the work was carried out by Messrs. Dryden and Son, Preston, whose workmen were still employed on the plant at the time of the explosion.

"On August 20 and 21 satisfactory preliminary trials of the engine were made. On Sunday, August 22, steam was used for the barring engine to place ropes on to the driving pulley, when it was noticed that the steam trap connected to the separator was not working properly, and it was decided to fit another trap. As a temporaray measure, the defective steam trap was removed and a straight-through drain valve and pipes, 1-in. bore, were fitted, the pipes being led through the engine house door, discharging into the mill yard. These alterations were completed on Monday, August 23, when a final trial of the engine, under load, was made, preparatory to supplying power to the mill by the new plant on the following morning. This trial was quite satisfactory.

"At the end of the trial the mill engineer found that he could not shut the engine house door without removing the end length of the temporary drain, which he removed, and as the discharge from the drain came into the engine house, he closed the drain valve, leaving it closed overnight. In mill practice the boiler stop valves are left open for heating purposes, steam traps being fitted to prevent accumulation of water in the steam pipes; the steam pipes were formerly well covered with non-conducting material to prevent condensation. In this case the work of covering the new pipes had only commenced, so that the drain valve being shut water would collect in the steam pipes overnight.

"The mill engineer states that his first action on the morning of the explosion was to open the engine house door, connect up the end length of drain pipe, and open the drain valve. The engineer, who was accompanied by the engine-builders' foreman, states that water came out of the drain pipe full bore. He then proceeded to oil the engine prior to starting, and states that about 7 minutes after opening the drain valve he heard a loud rumbling noise which was followed by a rush of steam. At this time there were present in the engine house, the mill engineer, the engine-builders' foreman and Thomas Scohill, a laborer, who was employed assisting the pipe coverers, and was injured by the escaping steam and water.

"The damaged pipes were taken down and repaired; the pipe which opened out at the weld was fitted with a patch 2ft. 3in. long, by 12in. wide and ⅜in. thick, riveted only ⅝in. rivets at 2in. pitch. The edges of the patch were electrically welded. The other pipe was repaired in a similar manner, the patch being 2ft. long by 12in. wide and ⅜in. thick. After being repaired, these pipes were hydraulically tested to 270 lb. per square inch and replaced. A new steam trap has since been fitted, which is working satisfactorily."

Mr. Carlton, engineer surveyor-in-chief to the Board of Trade, in his concluding "observations" says: "The conditions obtaining at the time of the explosion clearly point to the action of 'water hammer' as the cause; and it would appear that those in charge of the plant were not apparently aware that the clearing of water of condensation from a range of steam pipes whilst in open communication with the boiler is a most dangerous practice, and in this particular case the shock of 'water hammer' was most violent."

BUSINESS PAPERS EXTREMELY VALUABLE

IT WAS the reading of a business publication that inspired Henry Ford to quit the farm and seek employment which would help him to build a "horseless carriage" such as he then read about. It was by reading a business publication that George Eastman got the idea of establishing what has become by far the greatest establishment of its kind in the world. It was the reading and studying of business writings that started Frank A. Vanderlip on a career which landed him in the presidency of the largest national bank in America. Edison reads more business periodicals and books than perhaps any other man in America; he assured me that he couldn't afford not to.

Cyrus H. K. Curtis once told me, continues an editorial in Forbes Magazine, that he first conceived the idea of creating the Saturday Evening Post when, as a youth, he read a story about a young man who achieved dazzling success in business. It was reading and studying the business achievements of John D. Rockefeller that fired James B. Duke with ambition to become in tobacco what Rockefeller had become in the oil industry.

Only the other day a salesman of one of the many business "courses" now in vogue, told with great gusto that he had just sold his "course" to the president of a very large railroad, Daniel Willard, of the Baltimore & Ohio. J. Kindleberger, the famous paper manufacturer, tells how the reading of a business book caused him to organize what became a very successful enterprise.

Recognizing the infinite value of business books, "Forbes" has decided to open a new department to encourage the reading and studying of them by those who are ambitious to make headway in the world. As one means of emphasizing the benefits which can be derived from business books, they are offering $250 in prizes for letters answering the question, "Which Business Books Have Helped You Most, and How?"

It has become not uncommon, concludes the article, for employers to get a line on the kind of reading done by employees being considered for promotion. I once heard of an employer who made an excuse to visit the home of an employee whom he was thinking of promoting, but when the only reading matter within sight was a popular weekly and second-rate fiction, the employer concluded that he had better promote someone who devoted at least part of his spare time to reading periodicals and books calculated to widen his knowledge of his business and broaden his mentality.

The man who reads this story is to be congratulated, because he too is a reader of a business paper, and is thus building upon a solid foundation.

ANNOUNCEMENT

The Bailey Meter Company, Ltd., have now established Canadian offices at 179 Delorimier Ave., Montreal, and will manufacture Bailey meters in Canada. The Canadian branch will be closely affiliated with the parent company in Cleveland, Ohio. Mr. John Bryson, who has been in charge of the meter and instrument department of Peacock Bros., Montreal, will be Vice-President and General Manager of the Canadian company.

After being closed for over a year, the factory of the Central Spring Co., Oshawa, Ontario, started on January 9th, to get their factory in shape to resume operations as soon as possible. They will employ 20 men at the outset and expect in the very near future to have a full complement of 70 men working.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$26 00	$.....
1¼-in.	27 25	.....
1½-in.	26 25	
1¾-in.	29 75	
2 -in.	29 25	19 00
2½-in.	44 75	22 50
3 -in.	49 25	27 50
3¼-in.	.....	34 00
3½-in.	63 50	30 50
4 -in.	85 00	40 00

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$4 25	$3 90
Plates, ¼-in. up	3 75	3 50

Price List No. 38

PIPE—WROUGHT

Standard Buttweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
⅛	$ 6.50	$ 8.50	$	$
¼	4.89	6.99	5.91	8.01
⅜	4.89	6.99	5.91	8.01
½	6.50	8.03	7.95	9.48
¾	7.99	10.06	9.95	12.02
1	11.82	14.38	14.71	17.77
1¼	15.99	20.13	19.90	24.04
1½	19.19	24.06	23.79	28.74
2	25.72	20.13	32.01	38.67
2½	40.66	51.19	.....	.....
3	53.17	66.94	.....	.....
3½	67.62	84.18	.....	.....
4	80.12	99.74	.....	.....

Standard Lapweld Pipe
Per 100 Ft.

	Steel Black	Gen. Galv.	Wrot. Black	Iron Galv.
2	$29 42	$36 08	$35 71	$42 37
2½	44 17	54 70	54 11	64 64
3	57 76	71 53	70 76	84 53
3½	69 46	86 02	85 10	101 66
4	82 30	101 92	100 83	120 45
4½	95 89	1 20	1 30	1 54
5	1 12	1 40	1 52	1 80
6	1 45	1 81	1 97	2 33
7	1 89	2 37	2 53	3 01
8L	1 99	2 49	2 66	3 16
8	2 29	2 87	3 07	3 64
9	2 74	3 43	3 67	4 36
10L	2 54	3 18	3 41	4 05
10	3 28	4 10	4 39	5 21

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 50%.
4½-in. and larger, 40%.
4-in. and under, running thread, 20%.
Standard couplings, 4-in. and under, 20%.
4½-in. and larger net.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 5% off list. Malleable bushings, 22½%; cast bushings, 22½%; union, 37½%; plugs, 20% off list. Net prices malleable fittings: Class B black, 26c lb.; class C black, 17c lb.; galvanized, class B, 36c lb.; class C, 26c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ....base $6.50

FILES AND RASPS

	Per Cent.
Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Royalite Oil, per gal., bulk	28
Palacine	31
Machine oil, per gal.	58
Black oil, per gal.	27
Cylinder Oil, Capital	1.01
Standard cutting comp., gal.	06
Lard Oil, per gal.	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls., net	1.12

BELTING — No. 1 OAK TANNED

Extra heavy, single and double.	30-15%
Standard	15 to 40%
Opt leather lacing, No. 1	2 00
Leather in side	1.80

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	15%
Carriage bolts, 7-16 and up	Net
Coach and lag screws	—20
Stove bolts	55
Wrought washers	—25
Machine bolts, 7/16 and over	— 5
Machine, bolts, ⅜-in. and less	—30
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	+25
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square, tapped	add 2 25
Nuts, square blank	add 2 25
Nuts, hexagon, tapped	add 2 75
Copper rivets and burrs, list less	27½
Burrs only, list plus	10%
Iron rivets and burrs	37½ and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as al ve	8 40
Wood screws, ov. and rd., bright	67½
Wood screws, flat, bright	67½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$0 25
Solder, guaranteed	27
Babbitt metals	0 18 to 0 70
Soldering coppers, lb.	62½
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt.	17 00
Red dry lead, 100-lb. kegs, cwt.	15 00
Glue English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 42
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal.	1 20
Linseed oil, raw, single bbls.	1 00
Linseed oil, boiled, single bbls.	1 03
Plaster paris, per bbl.	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 75
Whiting, plain, per 100 lbs.	3 00

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$31 00	$34 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	33 00	38 00
Copper sheet, tinned, 14 x 60, 14-oz.	37 00	42 00
Copper sheet, planished, 16-oz. base	42 00	48 00
Braziers', in sheets, 6 x 4 base	35 00	41 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	17	Atlas	19
Peerless	22	X Empire	14
XX Grand	16	Ideal	18
Superior	21½	X Press	13
X L C R	15		

Colored

Lion	12½	Popular	10
Standard	11	Keen	9
No. 1	14	Fancy	14

Wool Packing

Arrow	30	Anvil	20
Axle	25		

Washed Wipers

Select white.	20
Dark colored.	13
Mixed colored	14

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 36
Pure Manila rope	26
British Manila rope	20
New Zealand hemp	20
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

Gross

METALS

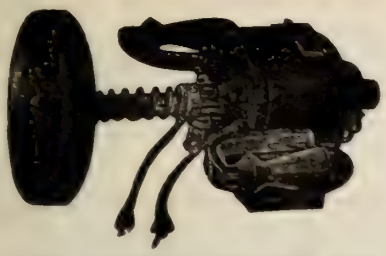
	Mont.	Toronto
Tin	34 00	$39 00
Spelter	7 25	7 50
Lead	6 50	7 50
Antimony	7 25	8 25
Aluminum	28 00	30 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 50	$14 50
Sheets, 3½ lbs. sq. ft.	10 25	14 00
Sheets, 4 to 6 lbs., sq. ft.	10 00	13 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.



The "Lagonda" Reseating Machine, Motor Driven with Emery Wheel

Boiler Efficiency

Demands the Use of

LAGONDA EQUIPMENT

"Lagonda" Boiler Tube Cleaner

1. THE LAGONDA RESEATING MACHINE: the most effective means known for removing scale from tube ends and caps. It removes obstructions and leaves the surface bright and polished so that the cap fits perfectly. Insures a steam and water-tight joint. Machine consists of an emery or carborundum cloth wheel driven at high speed by a motor.
2. LAGONDA BOILER TUBE CLEANERS: the simple, economical and sure way to keep boiler tubes free from scale. The use of a Lagonda Cleaner removes all deposits and the tubes are then practically as good as new. Cleaners are water, air or steam driven and designed for use in all sizes of tubes over 2-inch diameter. Made in types for every condition.
3. LAGONDA AUTOMATIC CUT-OFF VALVES: the safeguards of the boiler room. They are essentially safety valves, protecting life and property. Designed to close automatically in case of an abnormal flow of steam from either direction. From Asia to Alaska they boost boiler efficiency and eliminate accidents.

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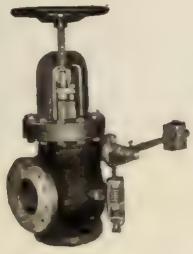


"Lagonda" Automatic Cut Off Valve

Valuable Accessories

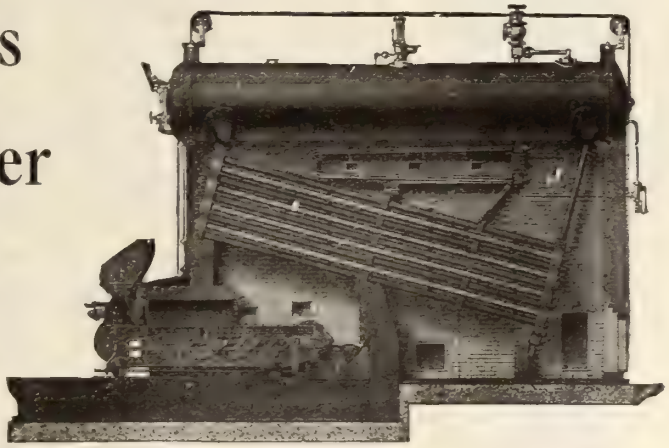
TO THE

"B & W" Steam Boiler

Combine LAGONDA Boiler Accessories with a "B. & W." STEAM BOILER and you have a boiler room with production ability second to none.

"B. & W." STEAM BOILERS set the world's standard for boiler efficiency. More than 50,000,000 H.P. are now in use in every country, on land and sea.

This place of leadership is the recognized tribute to a design devoid of all unequal strains—a design easy to clean, easy to erect and possessing sufficient durability for many years of service.



"B & W" Patent Water Tube Steam Boiler with Superheater and Mechanical Stoker

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R. C. Miller Oil & Supply Co., Ltd., Montreal

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R. C. Miller Oil & Supply Co., Ltd., Montreal

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BELTING, SOLID WOVEN
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BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.
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Sexton Boiler Setting Co., W. R., Toronto.

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The Mason Regulator & Eng., Co.,* Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

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Diamond Specialty Co., Windsor, Ont.
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Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

BOILERS
Gelinas & Pennock, Reg'd, Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
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C. B. Turner, Toronto.

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

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Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
C. B. Turner, Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd. Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd, Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co. Philadelphia, Pa

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER LINING, PLASTIC
C. B. Turner, Toronto.

BOILER SETTING CEMENT
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome,

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
C. B. Turner, Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Bovlig Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Waterous Engine Works Co., Brantford.

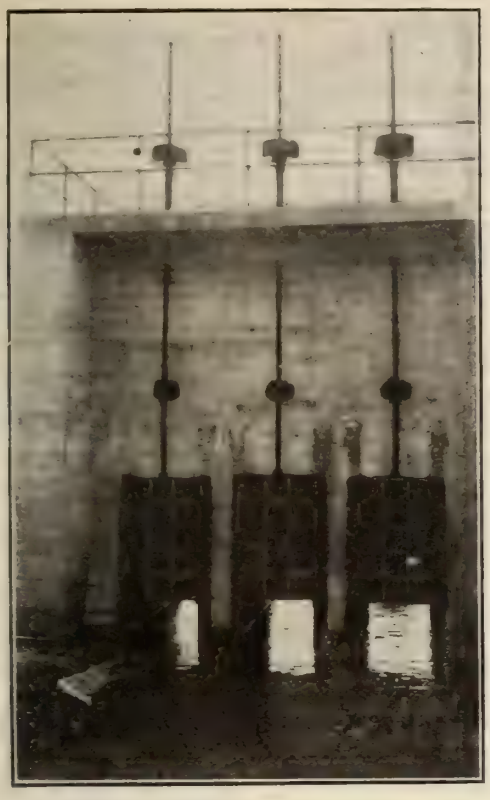
CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

CEMENT, HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd. Toronto.
Gelinas & Pennock, Reg'd, Montreal.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal.



COFFIN SLUICE GATES & VALVES

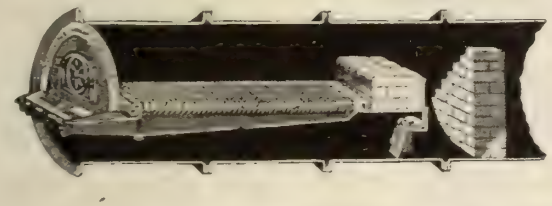
Selected for Important Duty

The picture shown here gives an instance of the important duty assigned to coffin equipment, which is a photo of three 3 by 5-ft. sluice gates supplied to the Nova Scotia Power Commission for their St. Margaret's Bay Development. Coffin equipment is thoroughly dependable. The Coffin line includes:

Electrically, Hydraulically and Hand-operated Sluice Gates, Gate Valves and Butterfly Valves; Check Valves, Flap Valves, Foot Valves, Shear and Slide Sewer Gates, Automatic Sewage Regulators, Fire Hydrants, and all such other devices for the control of water.

THE
ARTHUR S. LEITCH CO., LIMITED
1001-2 Kent Building, TORONTO

Why Burn Expensive Fuel—



When the
TURBINE (Patent) Furnace
Effectively Burns Coal Slack?

Turn to this method of heating and save many dollars a year. The highest form of fuel economy. For Externally Fired or Internally Fired Boilers. Burns coal dust and low grade fuels effectively. Consult us, now, about installing one.

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Sole Canadian Agent:
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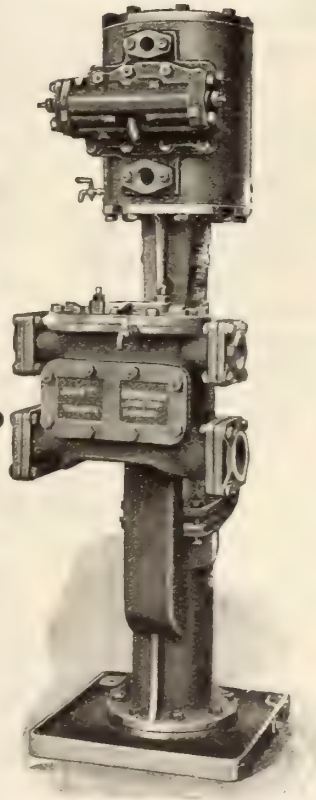
Minimize Pump Depreciation with a HEPBURN Patent Vertical RAM PUMP



In a Vertical Ram Pump of this type there is little wear on the cylinders. The weight of the piston and ram is taken by the water pressure and does not unevenly wear the glands and cylinders.
This pump will handle high temperature water at high steam pressures. There is a Minimum of packing required, ensuring a Minimum Leakage; Automatic Draining; No Tappets or Levers; All Parts Accessible. It runs full stroke even at slowest speed and occupies little space in the Power House.
We also make Cranes, Castings and Forgings. We will be pleased to have your business. You will be pleased that you gave it to us.

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Engineers and Iron Founders
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The Vulcan Soot Cleaner Co., Du Bois, Pa.
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Canadian Johns-Manville Co. Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLOSETS
Mueller Mfg. Co., H., Sarnia, Ont.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

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Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
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Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
MacGovern & Co., Inc., Montreal, Que.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

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Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
The John H. McGowan & Co., Cincinnati.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co. Ltd., Toronto.
Northern Electric Co., Ltd., Montreal.

CONDENSATION RECEIVER
The Mason Regulator & Eng. Co., Ltd., Montreal.

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal
MacKinnon Steel Co., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal

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Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co. Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP-FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Siroco Company, Ltd., Windsor, Ont.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRIC ARC WELDERS
Lincoln Electric Co. of Can. Ltd Toronto

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co. Ltd., Toronto.
Northern Electric Co., Ltd., Montreal.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
B. F. Sturtevant Co., Boston Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
Darling Brothers, Ltd., Montreal, Que.
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Sarnia, Ont.

ENGINE INDICATORS
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ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE, STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Canadian Siroco Company, Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Canadian Siroco Company, Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co. Philadelphia

EXHAUST RELIEF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N.Y.
Jas Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

FANS, VENTILATING
Canadian Siroco Company, Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Sturtevant Co., B. F., Toronto, Can.

FAN ENGINE REGULATORS
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co.

FEED WATER PURIFIERS
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

FILTERS
S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

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Beteon Plastic Fire Brick Co., Inc., Bonne, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.
C. B. Turner, Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., montreal.
Beteon Plastic Fire Brick Co., Inc., Bonne, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.
C. B. Turner, Toronto.

FIRE BRICK CEMENT
Beteon Plastic Fire Brick Co., Inc., Bonne, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Dart Union Co., Ltd., Toronto, Ont.
H. Mueller Mfg. Co., Sarnia, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane's Limited, Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
Jas. Morrison Brass Mfg. Co., Toronto.

FLANGED STEAM FITTINGS
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont

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Belts are expensive. The item of Belt replacements might run into good sized figures in some factories. The time lost in factory idleness while poor Belts are being repaired or replaced is worth more than the Belts. Buy the *Best*—because they *Last* longest and save *Time* as well as *Money*

The Brand That Stands For Quality

"P. M. S" Belting

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Crane's Limited, Montreal.

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Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co. Ltd., Toronto.

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Bailey Meter Co.
Dominion Flow Meter Co., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd, Toronto.
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Boving Hydraulic & Eng. Co. Ltd., Lindsay
Mackinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons, Pittsburg, Pa.

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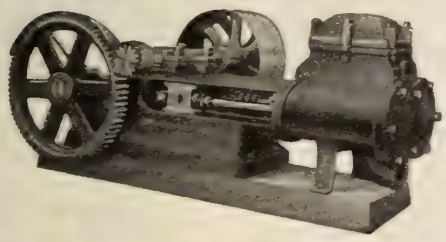

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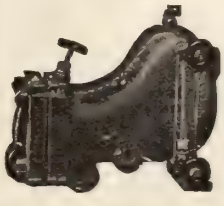

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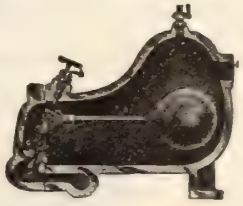

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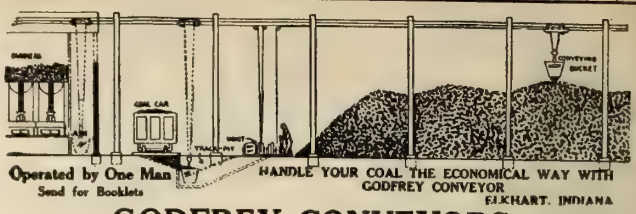

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SOFTENING & FILTRATION
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ARE MADE IN CANADA

Obtaining Increased Boiler Capacity at a Low Cost

With its 1,000 h. p. boilers working to the limit of their capacity, and with no floor or building space available for additional installation, a plant still needed 250 boiler horse power.

A new 250 h.p. boiler, with brick work and setting, but not including floor or building space, additional auxiliaries, etc., would cost $11,000.

Investigation disclosed that the capacity of existing boilers could be increased 25%, or 250 h.p., by the use of 150° superheat, through the installation of Elesco Superheaters; the cost, in this instance, delivered and erected being $6,000.

Equivalent boiler capacity increase, obtained through Elesco Superheaters, at a saving of $5,000.

No additional floor or building space required.

Little or no more fuel is consumed at the increased load than formerly; steam lines and engines are protected from the dangers of water hammer; entire plant operates more effectively.

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Pressure Gauges

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All steam pressure variations that occur for every hour of the day are indicated with precision on easily read charts. The fireman can tell immediately when more coal is required or other attentions needed. Consequently all waste is cut to the lowest figure.

In choosing Pressure Gauges always specify **"Morrison's"**. There's nearly half a century's experience at your disposal. Write us for further particulars.

Other lines we manufacture are Valves, Injectors, Ejectors, Inspirators, Clocks, Whistles, Bells, Pipe Fittings, Lubricators, etc.

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POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL: Southam Building LONDON, ENG.: 88 Fleet Street, E.C. WINNIPEG: 901 Confederation Life Building

Vol. XV.—No. 3 Publication Office, Toronto—Feb. 5, 1922 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

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Our illustrations are from photos of the Southern Canada Power Company's plant at Drummondville, Quebec.

The top view shows the completed dam—and the arrow points to the location of the Power House.

The lower view illustrates the splendid resisting qualities of concrete. The breaking up of the ice nine days before the completion of the work unexpectedly flooded the dam; yet the structure was uninjured by the severe strain thus suddenly placed upon it.

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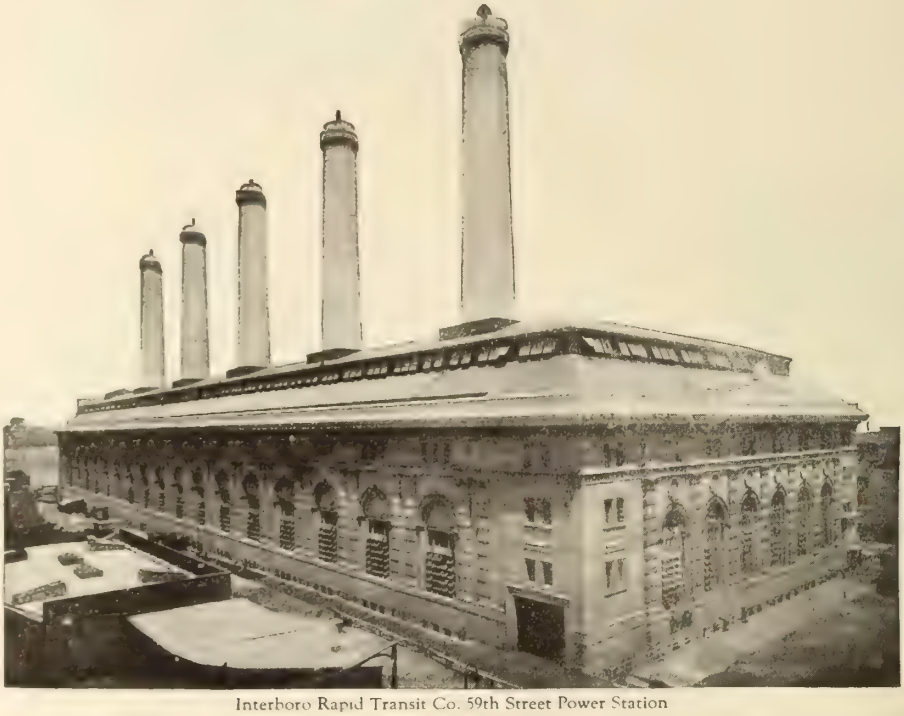

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are giving effective help by making the neighborhood around the above station a better place to live in. These fans, installed in connection with 600 horse-power boilers operating at 200 per cent rating, are catching 250 pounds of cinders per hour, instead of allowing them to collect on the streets and in the neighboring houses.

If you are facing a similar problem, we can help you solve it. Write our Mechanical Draft Department for further information.

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Carrying High Overratings on Natural Draft

Boiler ratings as high as 200% can be carried with poor quality, high ash and badly clinkering coals, on natural draft, when the boilers are equipped with

FILES HAND STOKERS

They insure clean fires all the time, without necessitating slicing, poking through open fire doors. Moving a few convenient levers mounted on the boiler fronts sifts the ashes, cleans the fire, breaks up all clinker and dumps the refuse into the pit. The labor saving is nearly as great as the coal saving.

The illustration shows a typical Files installation. Files stokers are also furnished with mechanical feed where plant is equipped for it.

Write for full particulars on the Files now.

Waterous

BRANTFORD, ONTARIO, CANADA

LUNKENHEIMER
"Duro" Blow-off Valves

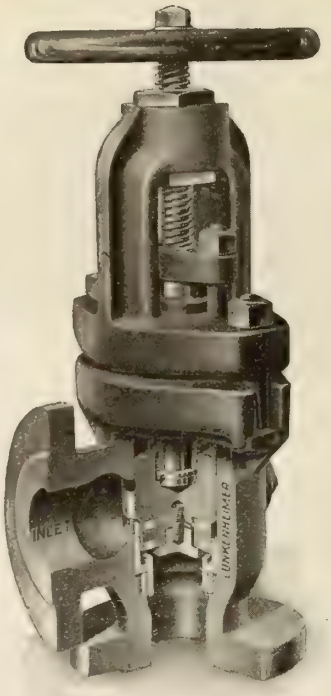

Fig. 897, Flange Ends.
Fig. 896, Screw Ends.

"Duro" Blow-off Valves prevent heat waste in blow-off lines. They remain tight under extreme operating conditions because they are not only made of wear resisting materials, but their design is such that the usual causes of leakage are eliminated.

The piston shaped disc secures a gradual release of the water due to its travel in the cylinder above the seat before full open position is reached. And when closing, the seating surfaces are automatically cleansed by the fine stream of water forced past the disc as it travels through the cylinder casing before seating. This action also minimizes wire drawing of the seat.

"Duro" Blow-off Valves contribute to efficiency and economy in plant operation and meet every blow-off requirement. Sizes 1¼ to 3 inches, in Iron Body Bronze Mounted Pattern for pressures up to 250 pounds.

Specify "DURO" BLOWOFF VALVES and insist on their installation.

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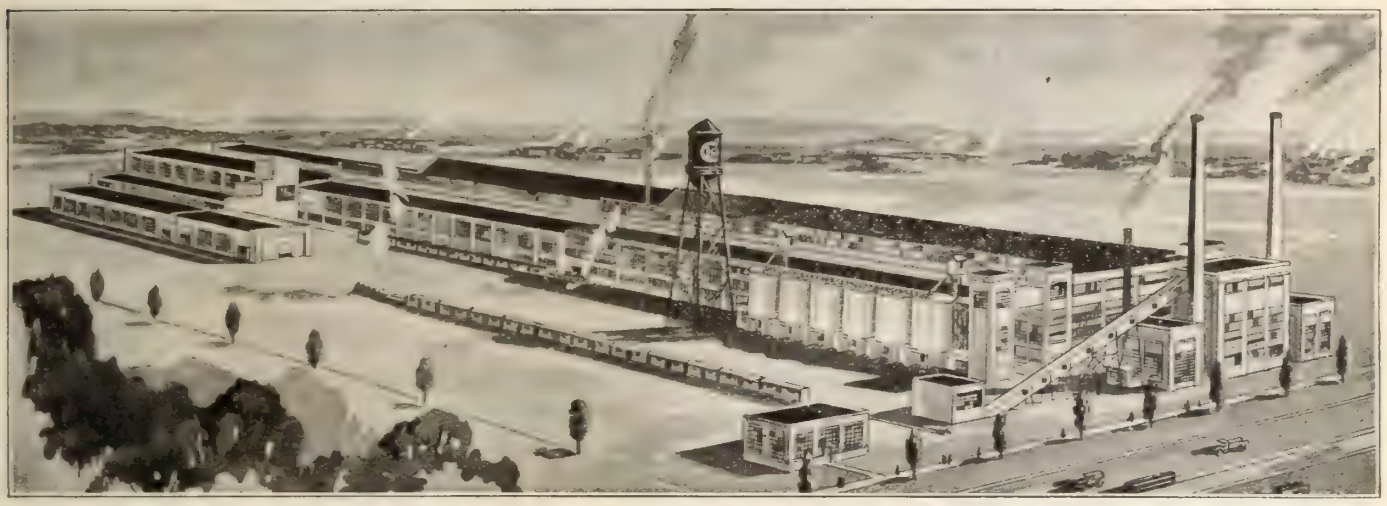
Jenkins Valves



The Libbey-Owens Factory at Hamilton Equipped With Jenkins Valves

Fig. 300. Jenkins Brass Gate Valve Type "K"

The Libbey-Owens Sheet Glass Co. Limited fully appreciate the importance of dependable equipment in the production of their "Made-in-Canada" Window Glass.

Knowing what an important part satisfactory, trouble-free valve service plays in efficient operation they selected Jenkins Valves as the most dependable and as guaranteeing that continued operation which precludes expensive replacements and "shut-downs" for repairs involving loss of time and labor.

Jenkins Valves are dependable and trouble-free because they are made by experts from the very best brass, iron or cast steel and **tested for maximum service before leaving the factory.**

There's a type and a size for every service everywhere. The complete line is fully pictured and described in Catalog No. 8, free on request.

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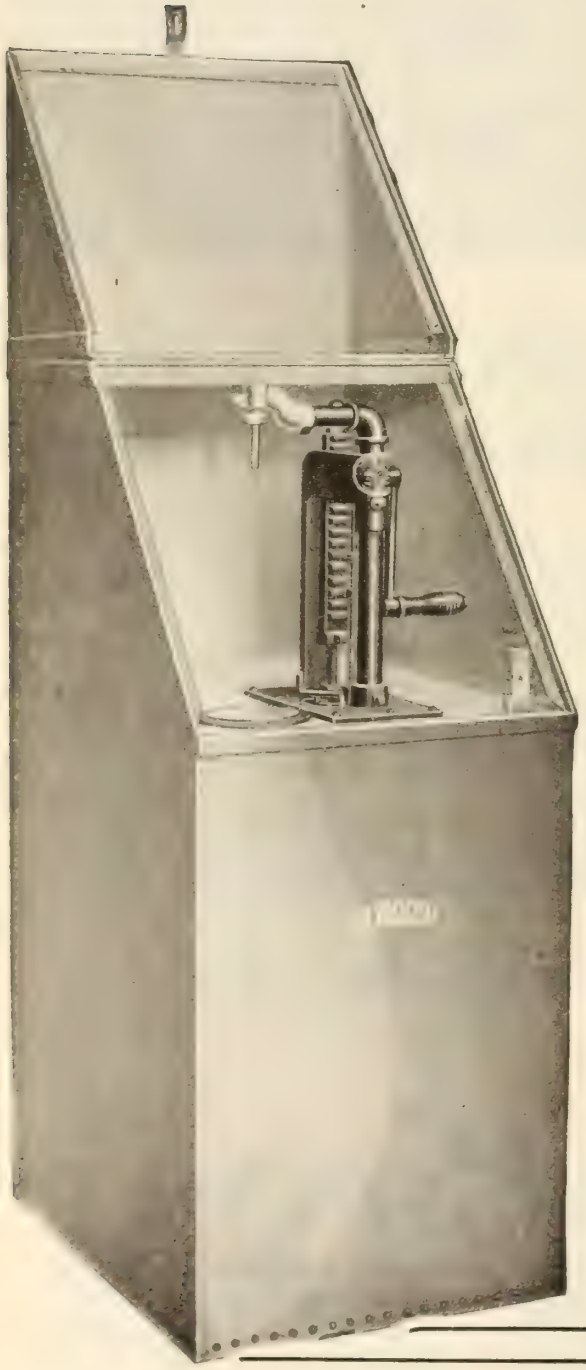
Incorrect lubrication will take its toll of your machinery slowly but surely. Undue depreciation is bound to result from the friction caused by gritty oil. And no matter how good the oil you buy, you cannot have correct lubrication unless it is *kept clean.*



By storing oil in Bowser leak-proof and dust proof Tanks, you will keep *your* oil clean and give better lubrication to your machinery. The Piston-Type Pumps deliver exactly the amount required directly into the distributing container, eliminating waste. Bowser centralizes your oil storage, making it easily accessible. The safety of Bowser is also an important element to consider.

Not once in 36 years has Bowser Equipment started or contributed to a fire.

Whatever your requirements, there is a Bowser to meet them. Ask us.

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IS
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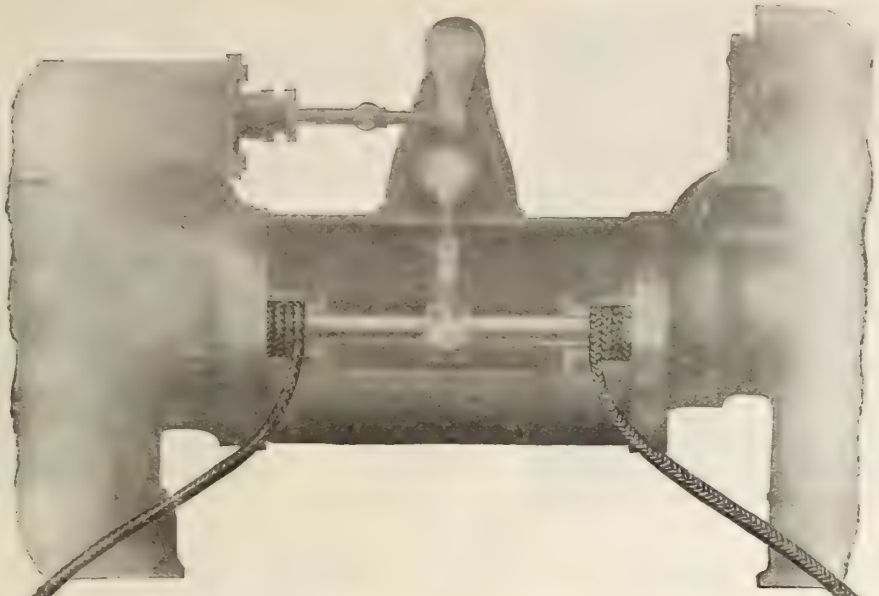

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Greater efficiency and economy can be secured by using in each service the packing best adapted to that service.

THE STEAM END

In addition to friction heat this service must contend with the high temperature of the steam, causing any packing not thoroughly heat resisting to quickly char and burn.

"PALMETTO"

is a packing that high temperature cannot affect and its perfect graphite grease lubricant prevents it from hardening, and keeps the rod well lubricated.

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Most of the packings for hydraulic pressures create excessive friction, swell, and so bind as to cause the pump to short stroke.

SQUARE PALCO PLAITED PACKING

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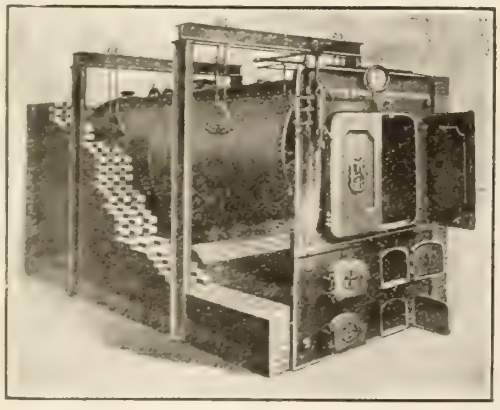

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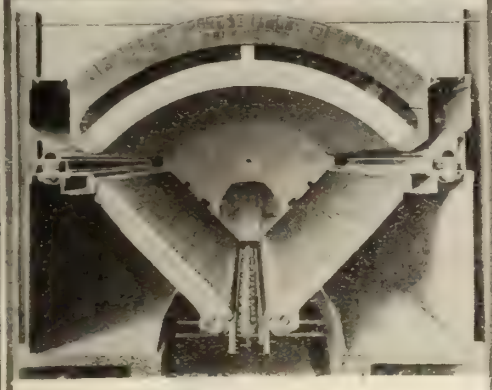
A request from you brings our Catalog H-2 describing the Murphy Furnace in ful



Factors Back of Every Installation of MURPHY FURNACES

Natural Draft—on everything except the most extreme peak loads. Will double the output of your boilers without one penny for draft.

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"A type to meet every stoker need"

"A type to meet every stoker need"

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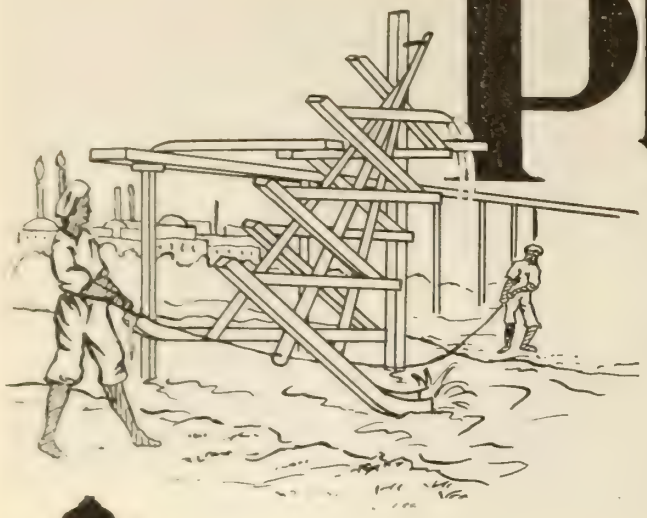
PUMPS



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The ancients had many peculiar schemes for making water run uphill, but none of them more peculiar than the Indian Rocking Pump. Two men and a rope furnished the "power." The water was rocked upward from one gutter to another, until it was finally emptied into a long trough and carried to the land.

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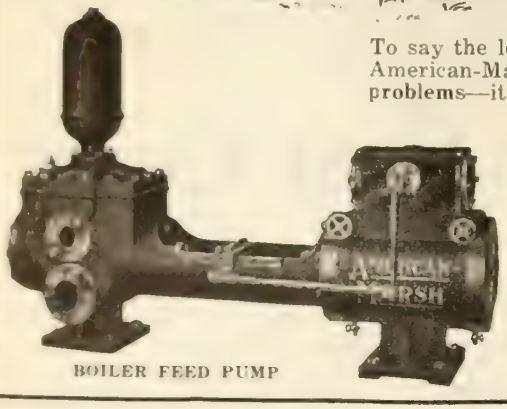
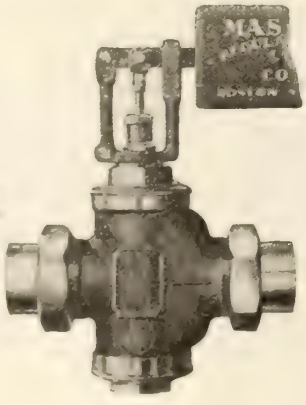


BOILER FEED PUMP

AMERICAN STEAM PUMP CO.
Battle Creek, Mich.

CANADIAN AGENTS:—A. R. Williams Machinery Co., Ltd., Toronto. Williams & Wilson, Ltd., Montreal. London Engine Supplies Co., Ltd., London. A. R. Williams Machinery Co., Ltd., Winnipeg. Mechanics' Supply Co., Ltd., Quebec. Gorman's Ltd., Edmonton and Calgary.

The American Marsh Lines also include Power Pumps, Compressors, Vacuum Pumps, Condensers, Deep Well Engines, Boiler Feed Pumps



Mason Self Closing Balanced Valve.

Ashton Pressure Gauge.

Mason Standard Reducing Valve.

High Signs of Steady Pressure!

Get uniform steam pressure, keep uniform steam pressure, and know when you have it. That is the combined purpose of these specialties.

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STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN

All parts made to gauge and interchangeable, making duplication of parts a matter of shipment from stock.

FIG. 7242

Steam Driven Outside Packed Plunger Pumps.

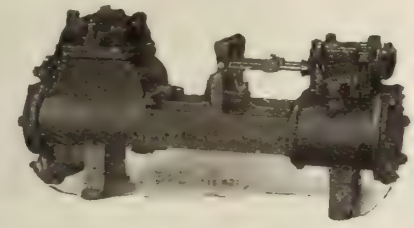


FIG. 7295

A full line of patterns in belted or direct connected power pumps.

FIG. 7284

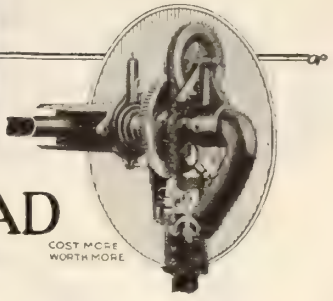
In addition to the Outside Packed Plunger Pumps shown we have a full line of Water End Patterns up to and including capacity of 5,000,000 U. S. gallons per 24 hours.

Established 1852

Give us opportunity to figure on your pumping requirements.

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

Practically Complete Elimination of Condensate Obtained



DIAMOND
VALV-IN-HEAD
SOOT BLOWERS

COST MORE WORTH MORE

One of the most important results of the use of the Valv-in-Head soot blower is the practical elimination of the possibility of water entering the portion of the soot blower inside the boiler. With all other blowers, the valve is located anywhere from 2 to 15 feet or more from the head. This means that condensation will inevitably take place when the valve is opened and steam is admitted to the cold line. The water thus formed is driven through the soot blower head and into the blower element.

In addition to the condensate thus formed in the line, a more serious possibility is that a small leak in the valve will cause water to form in the pipe before the valve is opened. When this occurs a solid column of water may be built up in the riser pipe and carried over into the boiler when the valve is opened.

With the Valv-in-Head system, any condensate in the main supply line is discharged through the drain pipe before blowing begins. There is, therefore, no water below the valve which can be carried into the blower head and the radiation area in the head itself is so small as to be negligible. Hence we have practically complete elimination of condensate from the blower element.

Constructional Features

The valve is made with Monel metal disc and seat. Both the stem and its retaining nut are made of nickel steel. In order to secure extra hardness which insures durability, the end of the stem is heat treated. Action of the cam and trigger are positive, assuring complete opening of valve at each revolution. Trigger, cam and clamps are steel, spring is chrome vanadium.

Ball thrust bearings—a new feature on soot blowers — are provided to relieve friction caused by thrust of unit. Special patented construction makes head full floating, permitting movement of unit in any direction as boiler walls expand or contract.

Valv-in-Head construction therefore means increased length of service of boiler tubes, complete removal of soot with no gummy deposits left behind, and long life of soot blower elements, with a reduction in annual blower maintenance charges from 25 to 50 per cent. This is only one of eleven important advantages of Diamond Valv-in-Head soot blowers. Every boiler needs a mechanical soot blower and you will save money by buying the best.

Diamond Valv-in-Head Soot Blowers are described and illustrated in detail in our new Bulletin 287. Write for your copy.

DIAMOND SPECIALTY CO.
WINDSOR, ONT.

Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

LINDE

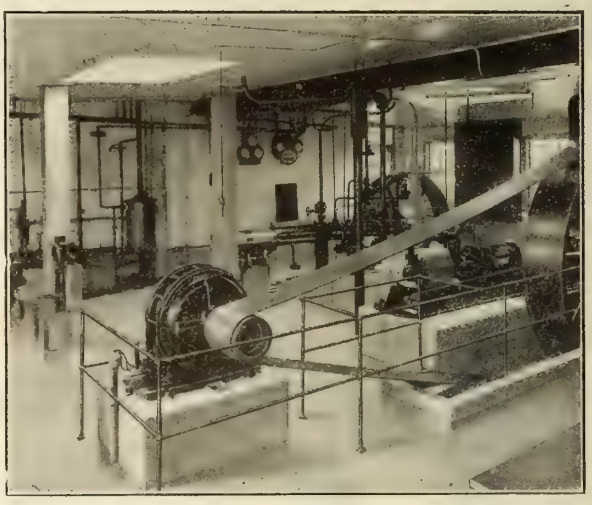
Made in Canada

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

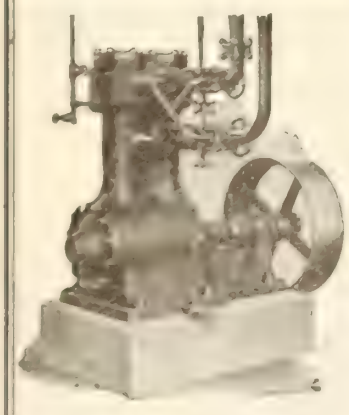


This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL,

TORONTO WINNIPEG VANCOUVER



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Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

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Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

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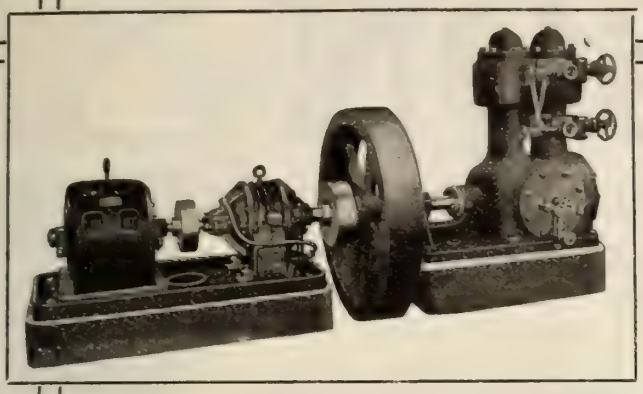

Write Our
Canadian Representative

CANADIAN ICE MACHINE CO.
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Eastern Harbor Terminals.
MONTREAL: 324 Craig St. West
WINNIPEG: 85 Lombard St.

QUALITY YORK SERVICE

YORK
REFRIGERATING MACHINERY

THERE is a YORK Machine to meet every practical condition of Mechanical Refrigeration—in capacities ranging from ¼ ton refrigerating duty upwards.

Installations by the York Organization are based on over 36 years' experience in building Ice Making and Refrigerating Machinery exclusively.

Get acquainted with our Sales Engineers. They are competent to give advice, and it is a part of their duty to share our knowledge of the business with any one contemplating the purchase of an Ice Making or Refrigerating Plant.

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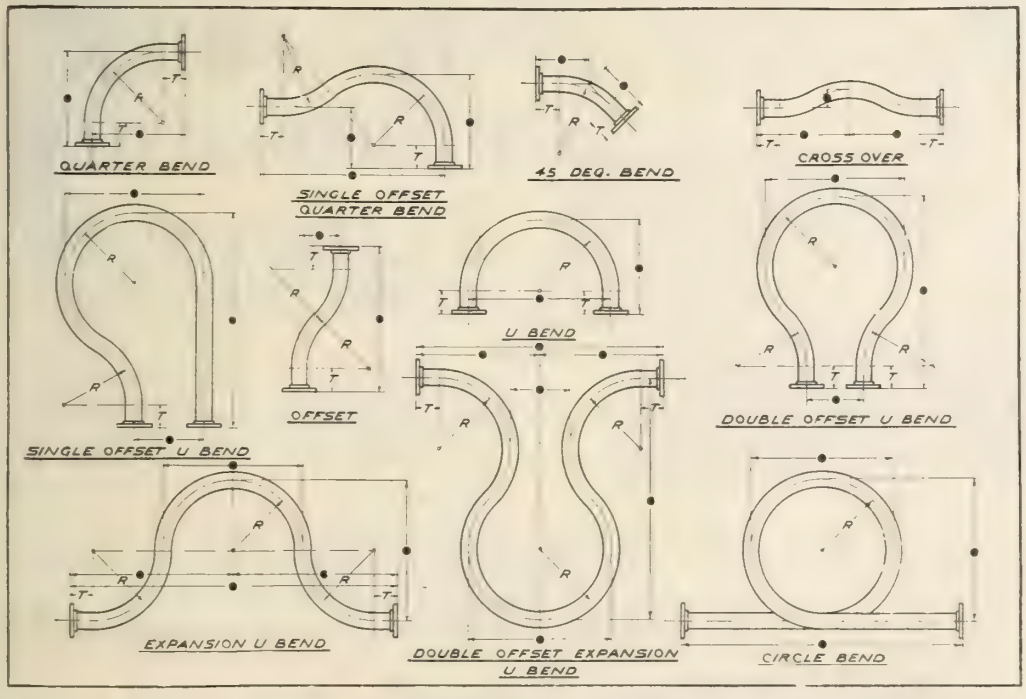

ALL KINDS AND SIZES UP TO 10" DIAMETER

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PAGE-HERSEY TUBES, LIMITED

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Formerly "JONES"

Heavy Duty Cold Storage Doors

In the **Jamison** line of cold storage doors you can get a door exactly suited to your requirements. Made for all conditions and purposes.

Shown here is our Standard Bunker Door—also our Entrance and Bunker Door combined. Special attention is drawn toward the Automatic Self-tightening Fastener and Adjustable Spring Hinges. They are heavier in construction and combine practical features not found in other doors. All hardware in Jamison doors is bolted to the door and frame; no wood screws used.

These are but a few of the features that have won for **Jamison** products the reputation of the **World's Standard** by their long, unfailing performance under all conditions.

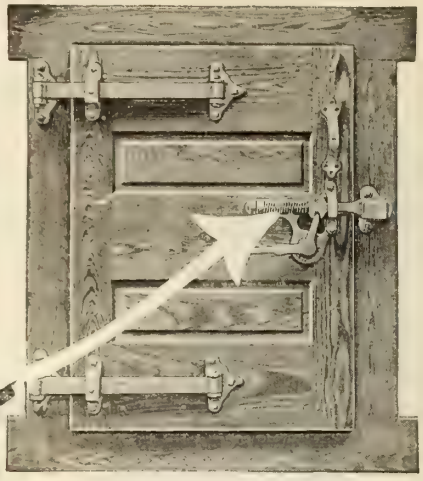
Catalogue No. 10 gives complete details—shall we send it?

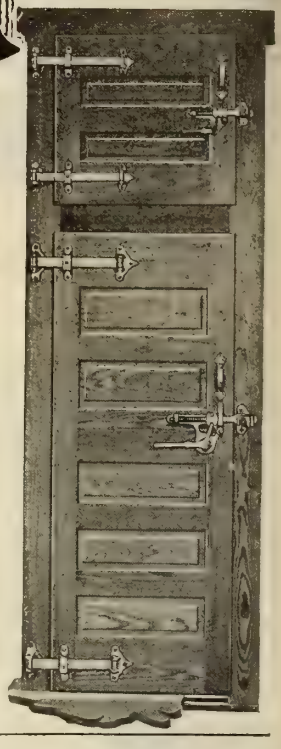
JAMISON COLD STORAGE DOOR CO.

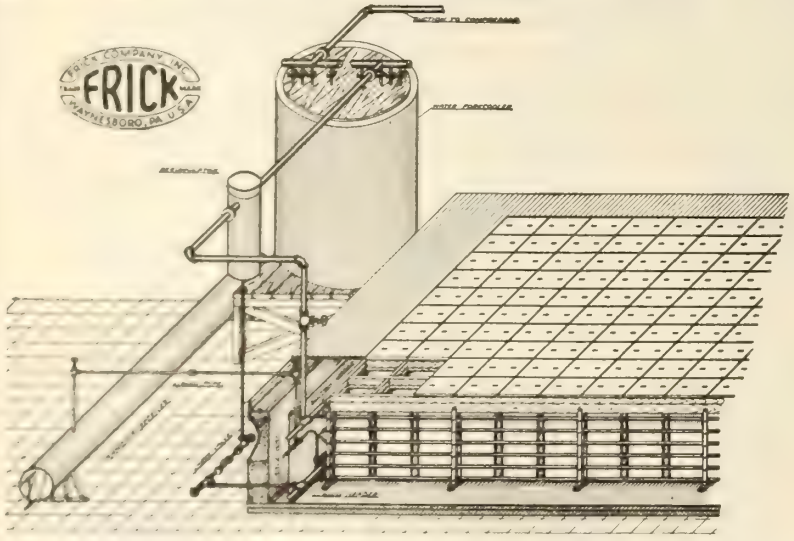
Formerly

JONES COLD STORE DOOR COMPANY

HAGERSTOWN, MD.
U.S.A.







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Its simplicity and dependability have made it a standard known the world over. Its success is unqualified.

It

Simplifies plant operation by reducing the number of feed valves to be regulated.
Increases plant efficiency by insuring uniform operation and giving absolute control of the ammonia.
Adds to plant safety by preventing priming accidents.
Lowers first cost of plant by increasing the heat transfer through the evaporating surface, thus reducing the amount of surface required.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

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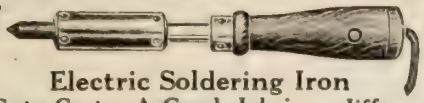
There is a FRICK Machine for every refrigerating purpose —all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal.

VIMY



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"Plenty of time before spring." Is there? Sixty days go pretty fast. Are you preparing for warm weather by insulating your rooms now, or are you putting it off to be caught in the last minute rush?

The best way to be sure that your rooms will be *ready* is to get at them now, in your slack season. And the best way to be sure that your rooms will be *right* is to use

NONPAREIL CORKBOARD INSULATION

For All Cold Storage Rooms

Nonpareil Corkboard has remarkably low heat conductivity. It is non-absorbent of moisture and does not deteriorate in service.

Nonpareil Corkboard is reasonable in cost and, equally important, it is the least expensive insulation to erect. Being uniform in quality and dimensions, it is ready to use without sorting and trimming. Straight edges and square corners make tight joints and eliminate waste of time, labor and material.

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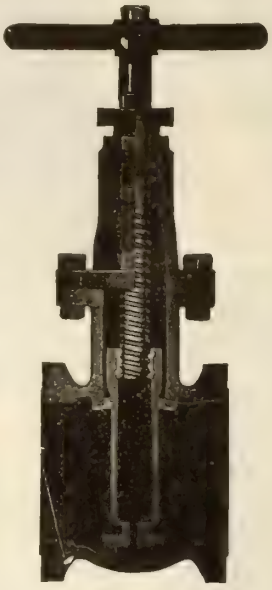
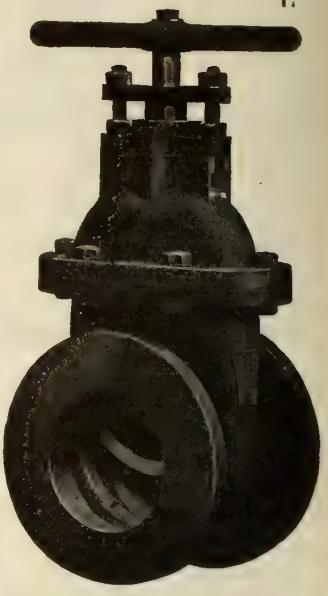
If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.



If you have been using them, we are confident that our satisfaction will bring us your repeat orders These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.



When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

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MAGNOLIA ANTIFRICTION METAL

TRADE MARK

"New Truths and Old Fallacies"

WEARING QUALITY

We mentioned previously the fact that the small particles worn from the surface of a Magnolia lining by the microscopic cutting edges of the shaft are usefully expended in filling in the interstices of the shaft, thereby imparting to both shaft and bearing a hard, glassy finish.

After this conditioning the wear practically ceases, or progresses so slowly that often it is hardly appreciable after ten years or more of service.

The conditioning of a bearing is its crucial period, but in the case of Magnolia it does not seem to matter even on a rough cast bearing, so promptly does it adjust itself.

We have records of Magnolia bearings on ice machine engines that have been in service equivalent to over thirty years, based on ten hours a day run, and which, from last accounts, were still running in good shape.

We have a number of records of twenty years or more of service, and reports of bearings running five and ten years, and still running, are too frequent to excite special comment, and we are in constant receipt of splendid testimonials.

During the first period of conditioning a bearing, there is naturally some rise in temperature, but with a Magnolia bearing this never reaches the danger point, and gradually assumes a low fixed temperature.

Both Professors Smith and Goodman state that Magnolia's best qualities show when subjected to heavy pressure. This cannot be said of most other babbitts because the grinding effect of the shaft causes rapid wear and heating.

(Continued next month.)

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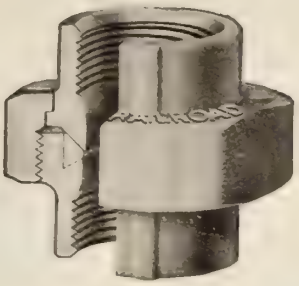

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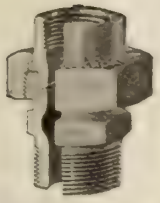
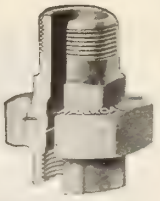


No. 517 Reducing Pump Stud Union.



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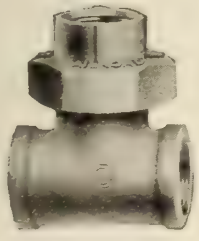

No. 598 Tee Union on Outlet.

Manufacturers of Valves, Fittings and Piping Equipment and Distributors of Pipe Plumbing and Heating Supplies.

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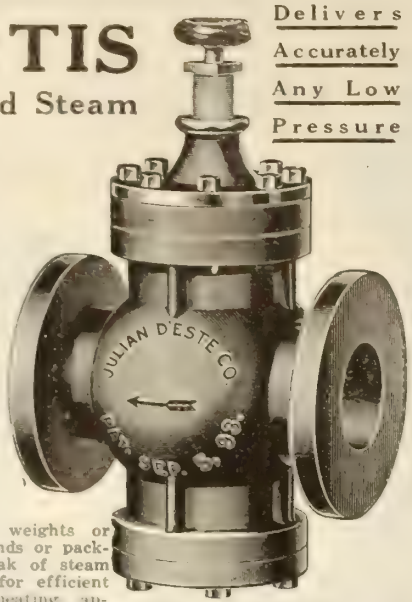
It has no levers, weights or projections; no glands or packing; no drip or leak of steam or water. Use it for efficient service on steam-heating apparatus, slashers, jacket kettles, air or water pumps, pulp mills etc.



The Improved Steam Pressure Regulator is a lock valve, very simple and sensitive. Send for descriptive pamphlet.

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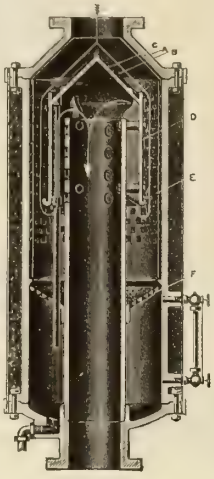
10,000 Sweet's Separators are serving discriminating steam users around the world.



Half of them sold on repeat orders. This record is backed by authentic tests, copies of which are mailed on application. For live steam mains or exhaust lines made in sizes from 25 pounds in weight to 25,000 pounds.

Read our story before buying.

Sweet's Separators

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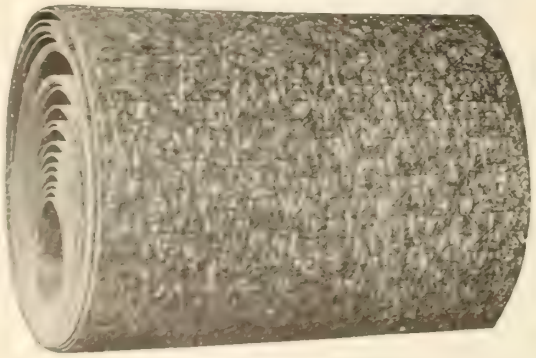
Extreme tests prove that Durabla Gaskets can withstand all Temperatures and Pressures without showing signs of Distress.



Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

Stock Sizes

36 in. wide x 144 in. long.

48 in. wide x 144 in. long.

In thicknesses of 1-64 1-32, 1-16, 3-32, 1-8

Let us send you a trial order.

DURABLA MANUFACTURING CO., NEW YORK
Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

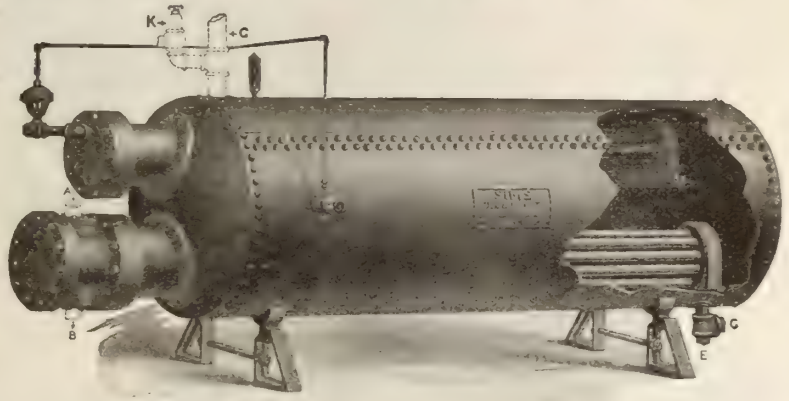
DURABLA

SIMS

CLEAN E-Z STEAM TUBE HEATERS

Style D, B-H

Showing clean E-Z Heater designed for using both live and exhaust steam — in separate tube structures.



Sims B-H Clean E-Z Storage Heaters are adapted for practical use in any plant or building requiring hot water, with either high or low pressure steam available as the heating medium. They are in widespread use and never fail to effect a substantial reduction in operating costs. For complete information write to:

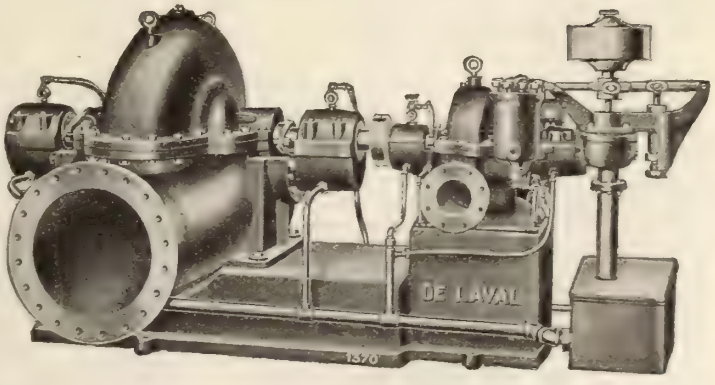
THE ARTHUR S. LEITCH CO.
LIMITED
1001-2 KENT BUILDING, TORONTO, ONT.

Turbine-Driven Blowers
Must be Rugged

THE DE LAVAL TURBINE-DRIVEN BLOWER unit shown is designed for gas plant work. It serves, however, to illustrate the care taken in designing De Laval apparatus to insure continuous, satisfactory service. Note the heavy construction of all parts, including the blower casing, also the forced lubrication with sight feed and the powerful and accurate speed governor, all features contributing to reliability in operation.

The same features are apparent in the design of all other De Laval apparatus, including turbine-driven generators, centrifugal pumps, blowers and compressors, speed-reducing gears, geared turbines for rope and belt drive, etc.

State class of apparatus in which you are interested and appropriate literature with special data will be supplied. Ask for Catalog F-100.



De Laval velocity-stage turbine driving single stage gas blower 11,000 cu. ft. of free air per min. against 33 in. water column at 3,600 R. P. M.

DE LAVAL STEAM TURBINE CO.
TURBINE EQUIPMENT CO., LIMITED
73 King Street West, Toronto
THE E. LAURIE COMPANY
243 Bleury Street, Montreal
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Vancouver

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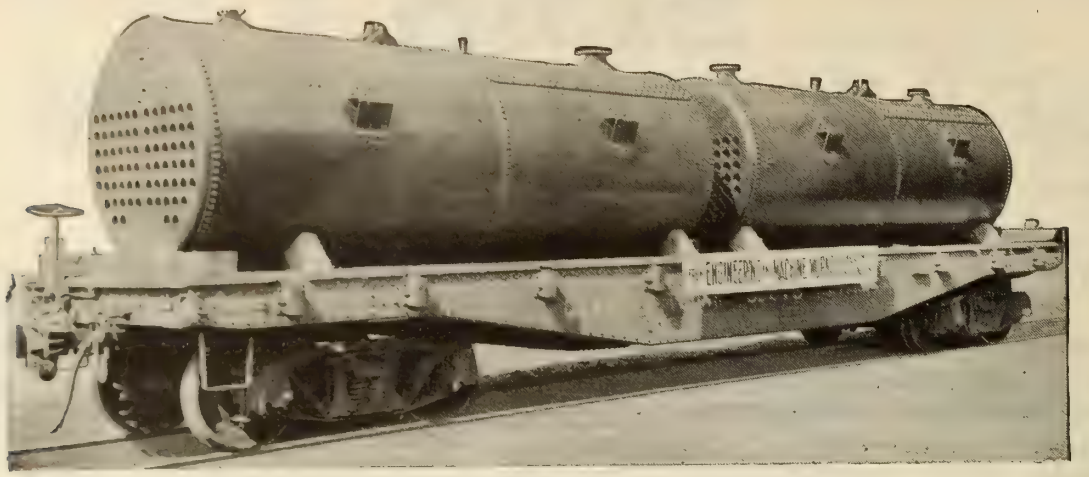


Money is Getting Cheaper!

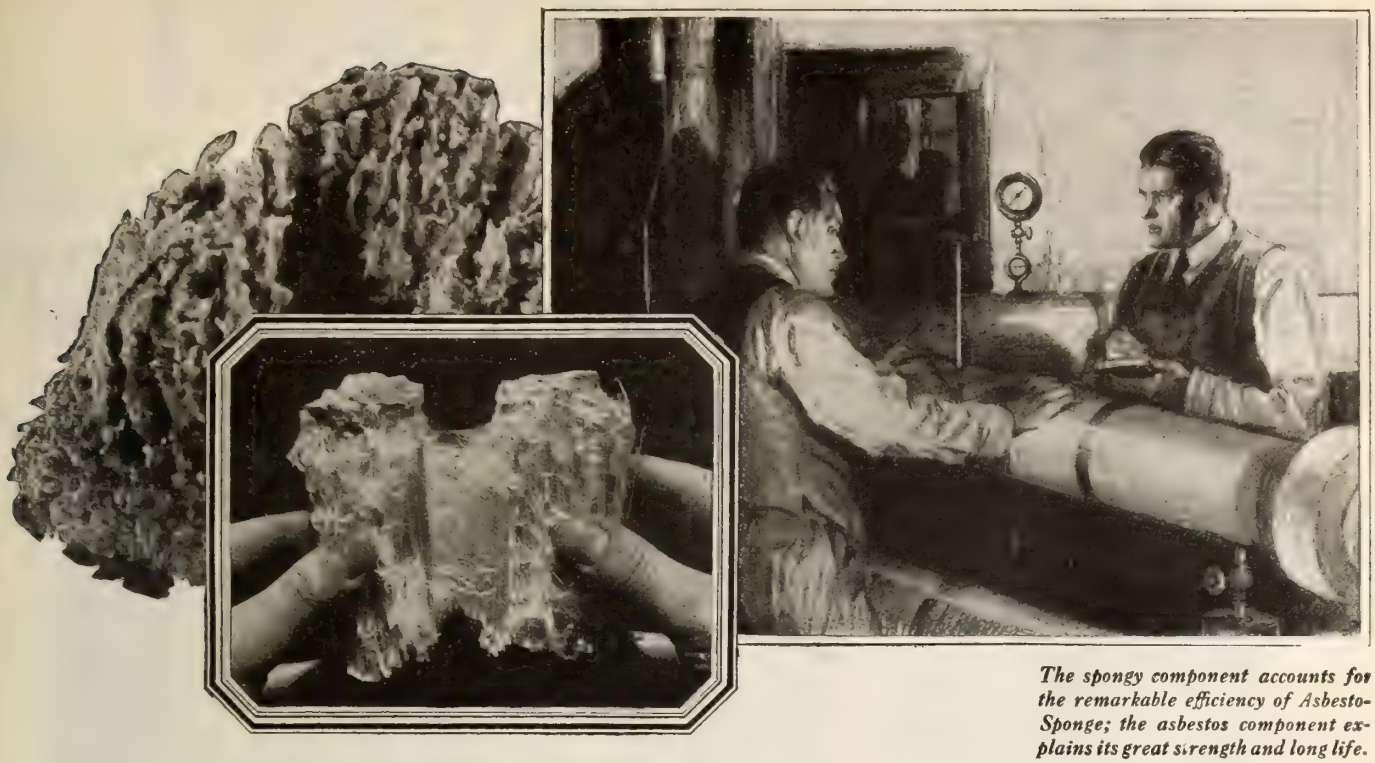
Money rates are down, the accumulation of funds looking for investment is climbing. First class bond issues no longer command the high rates of interest prevalent in 1921. This unquestionably means that industrial securities will have their chance ere long and more and more capital will look to business for its employment. Undoubtedly an increase in the general business of the Country will follow.

Is your plant in good shape? Particularly, are your Boilers modern, efficient and economical?—or are they steam wasters, coal devourers and always longing for the repair gang? Just because you don't see your Boilers at work very often—don't overlook the big opportunities there are for money savings in this department. We make modern Boilers of all types for power or heating, our workmanship is unsurpassed, and our prices are certainly low enough to-day to interest you.

Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal



The spongy component accounts for the remarkable efficiency of Asbesto-Sponge; the asbestos component explains its great strength and long life.

Dead air—
first aid to live steam

WHEN your steam pipes show symptoms of falling pressure and high external heat, cover them with Johns-Manville Asbesto-Sponge—the insulation which develops the dead air principle to its fullest extent.

The base of Asbesto-Sponge is asbestos, with which is mixed a spongy material whose countless dead-air cells form a natural barrier to heat. This insulating property is greatly strengthened by the laminated construction of the covering, for between the layers are dead-air spaces which also check heat loss. But it is not enough that this insulation should be the most efficient on the market.

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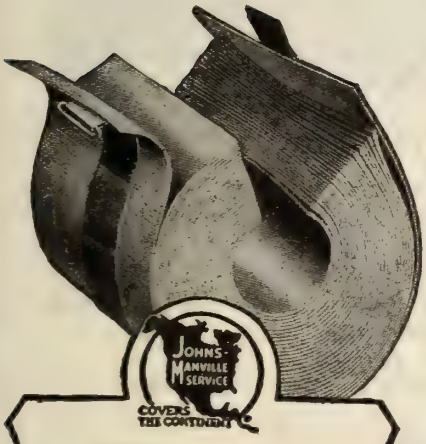

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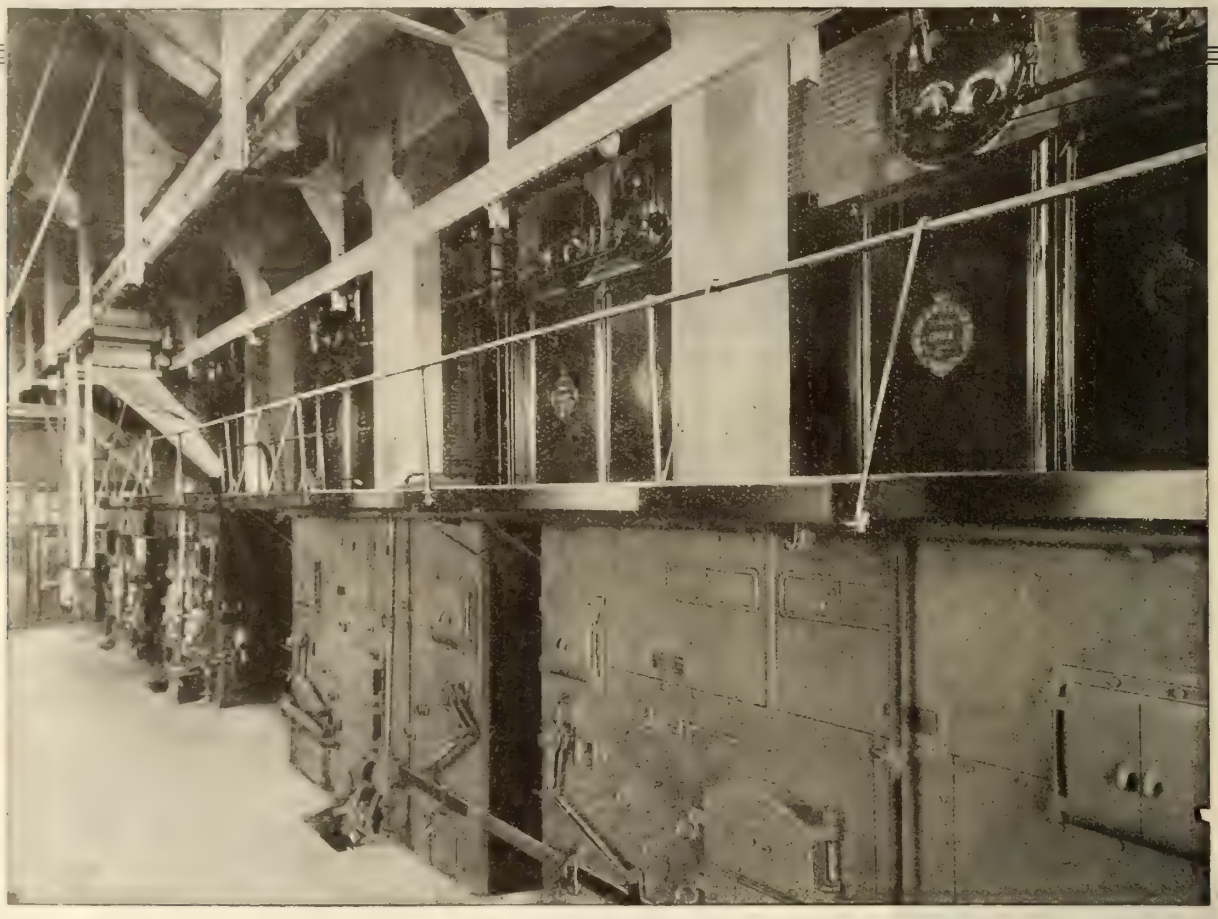

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The Gas and Oil Engine In The Power Plant

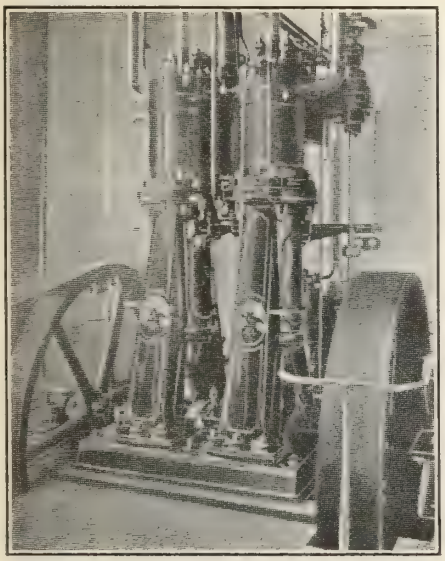
In This Article a General Description of Three Different Types of Four-Cycle Full Diesel Engines is Given

By T. H. Fenner

THERE has been a steady development in the use of the internal combustion engine for stationary purposes in the past few years, in the United States and Canada, while in Europe development for both stationary and marine purposes has been steadily carried on. The engines in use in this country are practically all of British, or European or American build, although at least one company in Canada has built a Diesel to their own designs, which has been described in these columns on previous occasions. This engine was also exhibited at the Toronto Exhibition of last year, and was the subject of great interest to a large number of visitors.

Gas engines, as distinguished from gasoline, or the crude oil type of engine, are found in this country chiefly in steel works, where the waste gases from the blast furnace are used as fuel, after passing through suitable washers and scrubbers. There are some fine examples of this type in the Algoma Steel Co.'s works at Sault Ste. Marie, the installations having been made by the Mesta Machine Co., Pittsburgh.

Gas engines using town gas or producer gas are in very wide use in Great Britain, but this form of power does not seem to have been used in Canada to any extent. There is of course the question of heating which is an ever present one in this country, and which makes in many cases the steam unit the most desirable. However where low grade coal is available, suitable for producer use, and both oil and steam coal are dear there is a possibility of the gas engine with the gas producer filling the need. The writer recalls one plant where a very fine gas engine and producer was installed, in the plant of a convent, which already had a most efficient steam generating and heating plant, and a small ice-making plant. There was absolutely no necessity for making any alteration, excepting that the man who was instrumental in getting the installation approved by the good sisters was in need of money. Needless to say, from one cause or another that engine was never turned over from the time of its installation until

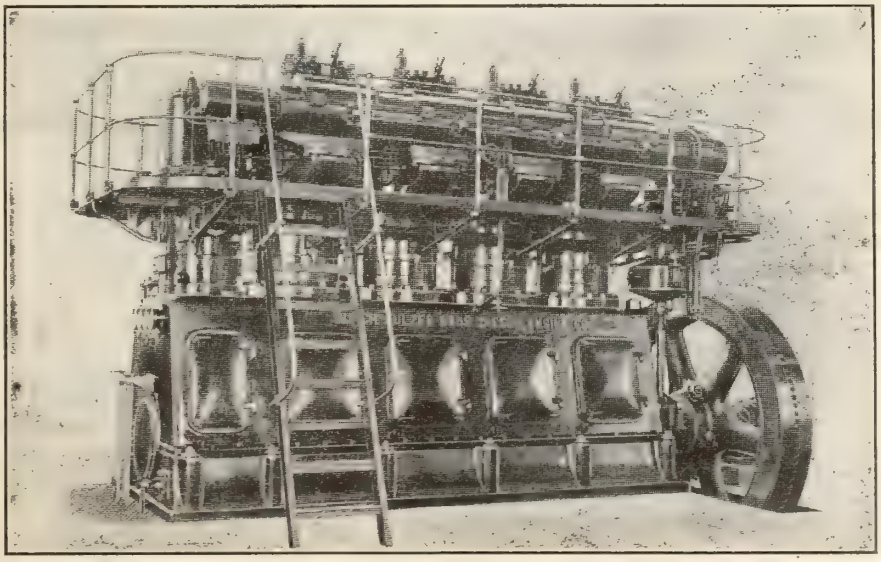


The first Diesel built in America

the writer's knowledge of the plant ended, which was two years after. A new engineer took charge shortly before that who had never seen a gas engine or producer, so it is possible that the plant is still lying idle. The only excuse for mentioning this case is to point out that the final decision on any installation should be the result of long deliberation, and a careful comparison of the possibilities of the various types of power generators. A good type of engine installed in a place where the requirements do not allow it to perform to advantage, gets a bad reputation, which extends in the minds of those immediately in touch with the circumstances, to all others of the same type. The man who sold the gas engine referred to thought more of making that one sale than he did of future sales, and the result was that his first sale was as far as the writer knows his last in the locality.

The First Diesel

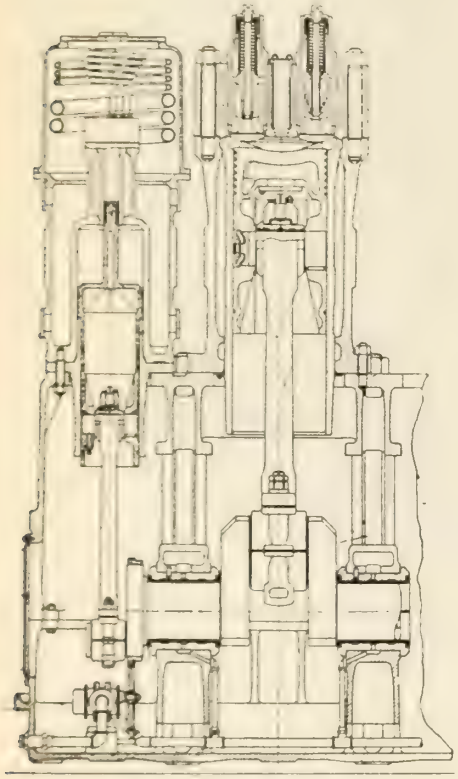
The first Diesel to be manufactured on this continent was made in St. Louis in 1898, by the Busch Sulzer Bros., Diesel Engine Co., and was installed in the Anheuser-Busch Brewery. It is claimed to have been the first Diesel engine to operate commercially in the world. We reproduce an illustration of the engine here, and it can be compared to the later types also illustrated. As in the case of the steam engine, there has been no improvement in the fundamental principle, all the alteration be-



Busch-Sulzer 4-cycle, 4-cylinder, 520 B.H.P. engine

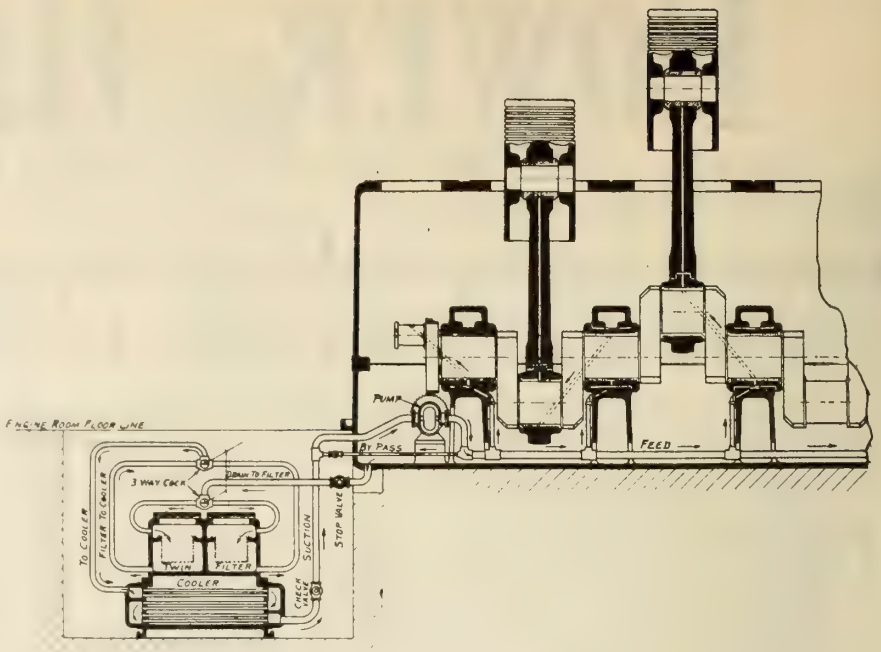
ing in details of design. The first engine was of 60 horse power, on two cylinders. It will be noted that the design of the bedplate columns and cylinders is much more like the steam engine than is the design of the later engines.

The second engine illustrated is a Busch-Sulzer 520 brake horse power Diesel engine, four cylinder single acting 4 cycle type. It will be noticed that in this engine as in all those built nowadays, the crank case is entirely enclosed. This allows for a forced lubrication system, and the reclaiming of all the oil used. The air compressor is shown on the end of the engine, and erected on the common bedplate. These air compressors are either two or three stage, with intercoolers, and while the engine is running a certain amount of air is passed into reserve bottles which are used for starting the engine up.



Cross-section of the cylinder and air compressor. pressor Busch-Sulzer four cycle engine

The bedplate in the engine illustrated which is known as the type B is made in one piece, the main bearing housings being formed by bridges cast between each pair of cylinders. The cylinder liners are made detachable, and are free to expand downwards, being supported at the top end only. The cylinders are water jacketed, and the cylinder casting makes a water tight joint with the water jacket at the top. The pockets for the various operating valves, that is, inlet, exhaust, air starting and fuel valve are contained in the cylinder heads, the valves themselves being of the poppet type. These valves are operated by a cam shaft which works direct from the crank shaft by suitable gearing.



Forced lubrication arrangement Busch-Sulzer engine

Governing is accomplished by means of a centrifugal governor, which varies the time of closing of the suction valves of the fuel pump, thus controlling the amount of oil admitted to each cylinder per stroke.

These engines have been installed in many varied kinds of plants, such as waterworks, electric light plants, and ice plants, in various parts of the world.

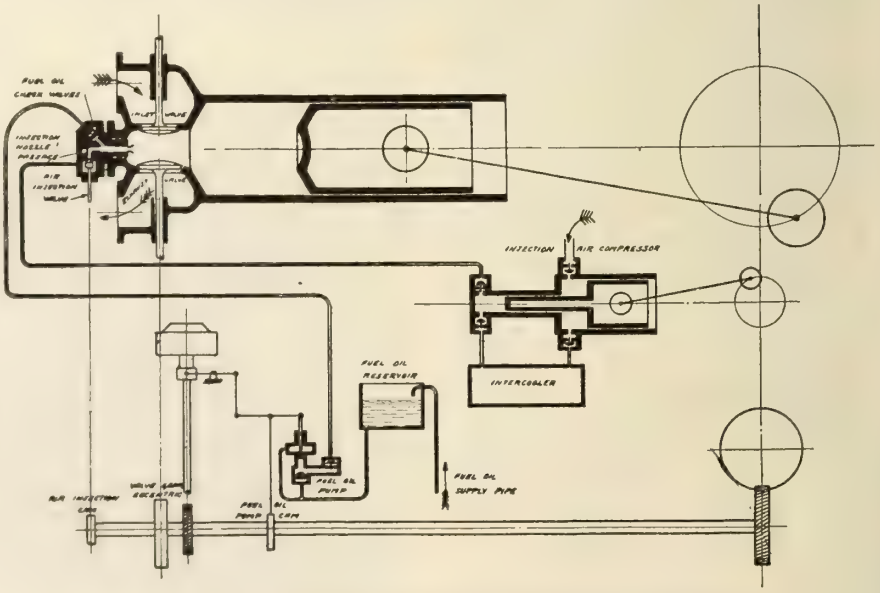
The Allis Chalmers Engine

The engine just illustrated was a vertical type, and as a contrast we show here the horizontal Diesel engine made by the Allis Chalmers Manufacturing Co. This engine is also of the four-cycle single acting type. These engines are made with one, two or three cylinders as may be required, and are adapted to a wide variety of uses.

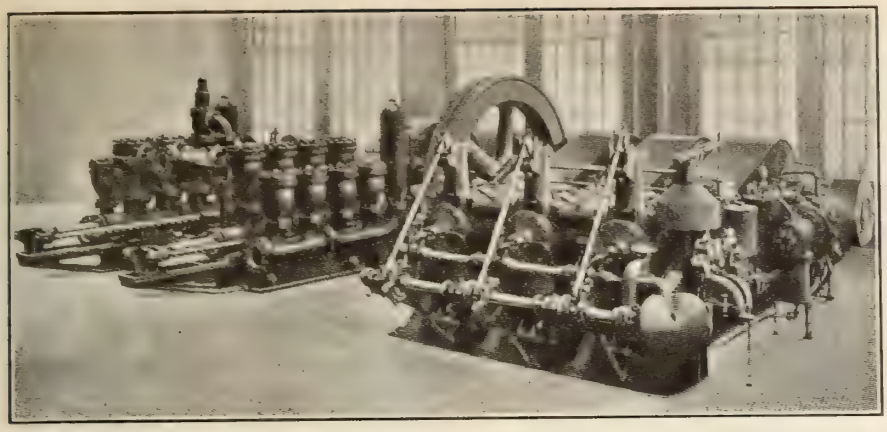
In this engine a separate air starting system is employed, which uses air of a much lower pressure than the air used for fuel injection. This eliminates the use of the storage bottles, and another feature is that the air for starting purposes is distributed through separate valves, the main valves and gear not being brought into play at all for this purpose.

The fuel oil is delivered through an open nozzle into a receptacle, during the suction stroke of the engine. This receptacle is also connected to the air supply, and the air under pressure is admitted to the receptacle after the oil is deposited, and the mixture is forced through an atomising device leading to the combustion chamber at the proper moment.

The governor in this case varies the fuel supply by means of a by-pass which allows a portion of the charge to return to the fuel tank instead of



Schematic diagram of Allis-Chalmers Horizontal Diesel



Three-Cylinder Allis-Chalmers Diesel Direct Connected to Duplex Pump.

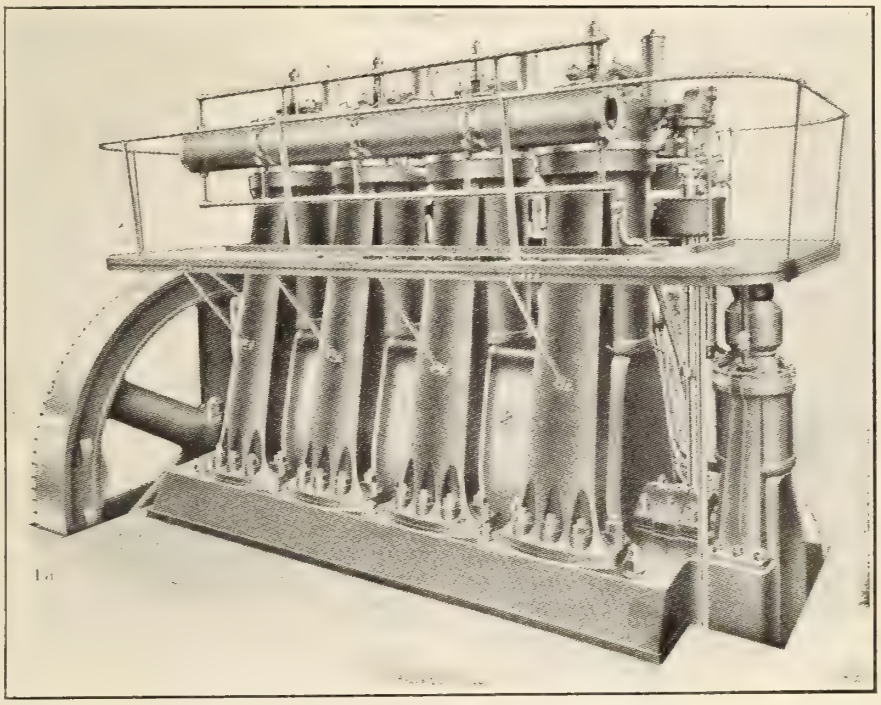
going to the oil receptacle in the cylinder when the engine is running light.

The horizontal form of construction allows a very rigid bedplate, and gives ready accessibility for overhaul and repairs.

The accompanying diagram shows the schematic arrangement of the engine very clearly. The piston is shown on its working stroke, with both inlet and exhaust valves closed. The two stage air compressor is shown, the differential piston accomplishing the two stages of low and high pressure compression, the low pressure stage delivering to the intercooler, and the high pressure stage delivering direct to the fuel chamber.

The arrangement of the fuel oil pump with its by-pass connected to the suction side from the discharge side can be clearly seen, and the arrangement of cam shaft and cams for operating the governor, inlet and exhaust valves, air injection valve, and fuel oil pump. The cam shaft of course is a half time shaft, that is it makes one revolution while the main shaft is making two. The details of the valve gear can be seen from the cross section shown.

A good illustration of the use of this engine is shown in which a three cylinder engine is directly connected to a duplex outside packed pump.



The "Polar" Diesel Engine.

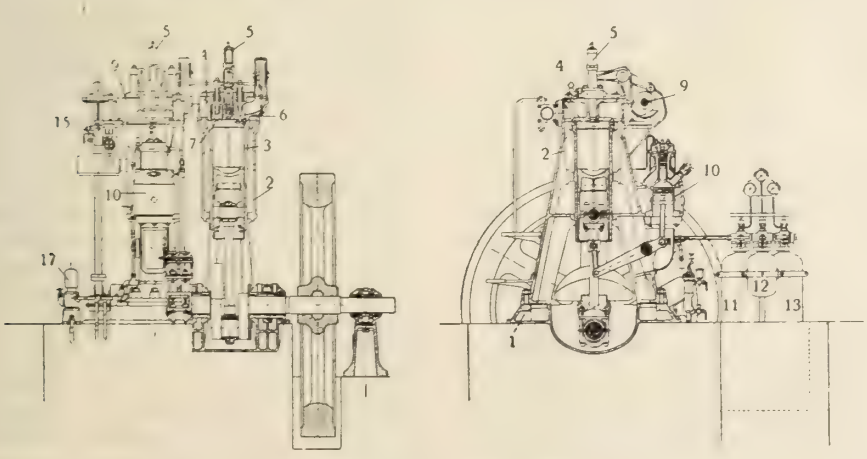
An European Type

A vertical four cycle Diesel engine made in Sweden by the Atlas Diesel Co., of Stockholm and handled in Canada by Lanmers & Maase, Montreal, is shown as affording an example of the design developed by European makers. The Diesel engine was adopted in Europe to a greater extent than in this country, both for marine and stationary purposes, and Sweden has always been a leader in this direction.

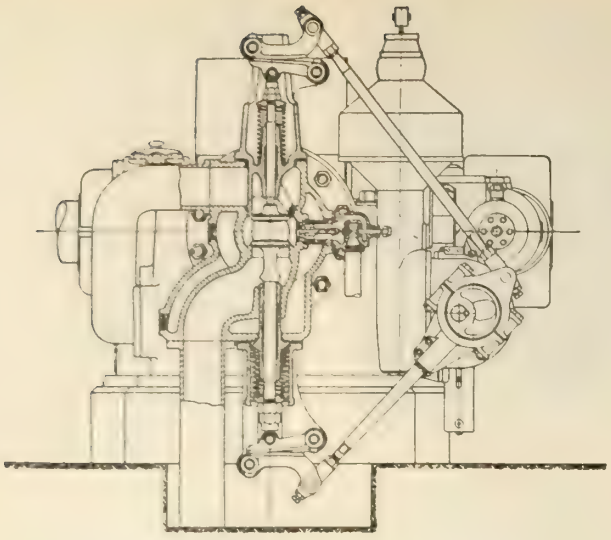
The principle of the engine is of course the same wherever it is built, and it is only in details that any difference can be noted. Thus it will be noticed that in the engine shown here, the air compressor is worked by means of a lever attached to the connecting rod of one cylinder, and is carried on the back of the engine, instead of at the end of the cylinders. The air compressor discharges into three different bottles, one of which is a spare receiver, the small one 12 being the injection air receiver while the third is the starting air receiver.

The cross section illustrated gives a good idea of the general arrangement, and the following description applies to the drawing.

On the bedplate (1) containing the main bearings are mounted columns (2) on which the cylinder liner (3) is fixed. The working cylinder is open at its lower end and closed at the upper end by the cover (4) containing the necessary valves. In each cylinder cover is one fuel valve (5) for the injection of the fuel, one air inlet valve (6), one exhaust valve (7) and also a starting valve for one cylinder on each engine. The valves are all controlled from the shaft (x). The air compressor built in tandem (10) produces the air necessary for starting and for injecting the fuel into the combustion chamber. The air is stored in the starting air receiver (11), the injection air receiver (12) and



Cross-section of "Polar" engine



Valve gear Allis-Chalmers engine

spare air receiver (13), the air compressor being of ample proportions f maintaining a sufficient supply.

The fuel oil is led in closed pipes (14) under low pressure to the fuel pump (15) which forces an amount of fuel corresponding to the load into the fuel valve (5). The fuel is then injected into the combustion chamber by means of air compressed to about 55—60 atm. from the above mentioned injection air receiver (12). The parts of the engine subjected to great heat, such as cylinder cover, cylinder, and air compressor, are water cooled, the water being obtained either from an ordinary outside pipe line (16) or through a water pump (17).

These three types give a good idea of the general construction of the Diesel engine for stationary purposes, that is as far as the full Diesel type is concerned. There are still the semi-Diesel and the gasoline engines to consider, and in the remaining articles we hope to cover some of these types, and also some detailed descriptions of plants where they are installed.

BRITISH AIR LIFT PRACTICE

At the latest meeting of the British Association, Dr. John S. Owens presented an interesting paper dealing with air lift pumping, his object being rather to call attention to the possibilities of the air lift than to indicate any final conclusions as to best design and application.

He had made some experiments with the object of producing the best pump for lifting acid mine liquors in the mine of San Domingos, in Portugal. The work that had been done convinced him that the low efficiencies usually obtained were not an essential part to get pump efficiencies with air lifts of between 60 and 70 per cent.

Causes of loss in air lift pumps could be grouped under the following heads: —(1) Slippage losses, due to relative motion between air bubbles and water; (2) losses due to friction of the mixture of air and water in the rising main; (3) friction losses incurred by the flow of water before air was admitted; (4) energy discharged in the kinetic form with the water and due to the velocity of discharge.

The losses under headings (3) and (4) were more or less under control. It was in connection with those under (1) and (2) that there appeared to be a good opportunity for increased economy.

Many experiments had been made already dealing with the question of submergence, and it had been definitely established that there was a most suitable value for this, the best efficiency being obtained with a submergence of about 70 per cent., that was when the length of submerged pipe was 70 per cent. of the total length—submergence + lift.

With regard to the loss arising from slippage, it was clear that a high velocity of the mixture tended to a slow slippage loss. The loss due to friction of the mixture in the eduction pipe was often considerable. It varied directly with the square of the velocity, while those from slippage varied inversely with the velocity, and the aim of the designer was to fix a definite value fof the velocity where the sum of the friction and slippage losses would be at a minimum. It was a well-established characteristic of air lift pumps that the highest efficiency was obtained at one particular delivery. The most suitable value for the submergence was best found experimentally, but seemed usually to be between 65 and 75 per cent. An appreciable effect was, however, to be obtained by very small variations in submergence. Taking v as the mean square of velocity in the pipe and f as the coefficient of friction, tests gave a value of f=0.025 in a 6⅝-in. pipe with v mean=13.3. The effect of nozzle diameter was found to be very slight, the governing factor being the rate of flow of air through the orifice. Describing the air lift mine pump, the author said that the installation was in two lifts—one of which raised the water from the 210 m. to the 180 m. floor, and the other raised the water to the 150 m. floor. It was found that the efficiency of the upper lift pump varied between 56.6 and 64.13 per cent., and that of the lower lift pump, from 52.5 to 66.1 per cent. The throat piece with the smallest diameter was found to give the highest efficiency—a result which was somewhat unexpected. The probable explanation was the effect on the size of bubbles. The smallest throat yet tried had a diameter of 3½ in., and this was being experimentally reduced to 2½ in. This installation had replaced a three-throw electrically driven ram pump which had been a constant source of trouble.

OTTAWA LODGE NO. 6, C.A.S.E.

A very interesting and instructive meeting was held by Ottawa Lodge on Wednesday evening, January 25, when Mr. T. A. Hatfield, of the Babcock & Wilcox Co., entertained the members to an excellent illustrated lecture on Babcock & Wilcox boilers. Mr. Hatfield gave some very useful information both as regards the early development of the boiler and the present day designs for burning either coal or oil and also especially designed furnaces for burning the various fuels used in different parts of the country.

A good attendance and great satisfaction were two of the good featur of the evening.

The Examinations of Grand Lodge Educational Committee are receiving their full share of discussion by our Lodge and good results are looked for.

A VALVELESS, GEARLESS ENGINE

Any user of internal combustion engines will need no strong argument for the advantage of doing away, if possible, with valves and gears, both of which are a fruitful source of operating difficulties. The idea of an engine without valves or gear has been realised in Great Britain by the construction of an engine which, in the works at least, has given remarkably promising results. This engine has three cylinders; and except for the ports it has no valves. There is not a single gear wheel and all the usual cams, shafts, tappets and springs —even the timing gear—are cut out. The only moving parts are the crank shafts, pistons and connecting rods. The experimental engine was rated at ten horse power and on test developed twice as much. The cycle of operations is not easily described without a detailed diagram but it must be said to depend upon ingenious inter-working between the three cylinders. This engine has been specially designed to meet the conditions in overseas countries, where an extremely simple engine not requiring difficult repairs is for obvious reasons in great demand.

Packing a Rod For 500,000 Lbs. Pressure

The Necessity for Packing Against Pressures Running From 300,000 lbs. to 500,000 lbs. per Sq. Inch Arose During the Making of Some Laboratory Experiments. The Methods Adopted Should Interest The Power Engineer

By P. W. BRIDGMAN.

I RECENTLY described some experiments at Harvard University with extremely high pressures. These pressures were of the order of 300,000 lbs. per square inch or ten times the firing pressure of a gun. One absolute essential in handling such pressures is a suitable method of packing the joints, says Mr. P. W. Bridgman in the "Compressed Air Magazine."

Since this question has aroused some inquiries, and since the principle of the packing is applicable to any pressure, I shall describe the packing in principle and some of the details of its application. I shall also describe some results of engineering interest obtained from the high pressure experiments which were only briefly alluded to in the former article.

The principle of the packing will be obvious from a study of Figs. 1, 2 and 3, which illustrate three stages in the evolution of the packing. In Fig. 1 is shown the ordinary method of packing a joint applied to an air pipe connected to a large vessel. Such a packing is familiar to anyone who has pumped an automobile tire. The packing material is squeezed between two opposing members with sufficient force to prevent the air or water, or whatever is carried by the pipe from leaking. The weakness of this packing is at once evident. The packing material squeezes out between the opposing members if screwed up too tightly, so that the joint has to be continually retightened, until eventually all the packing material escapes. The pressures that this packing can handle are moderate, the limit is set by the pressure that blows out the packing.

A modification of this arrangemen by putting a retaining rim around the outer edge of the packing as shown in Fig. 2, prevents the packing from squeezing sideways, and greatly increases the pressure that it is possible to pack against, because the packing itself may be subjected to a much greater pressure without lateral escape. It is still better if the opposing members are brought into contact with a direct straight push instead of by the rotary motion as in the figure, which has danger of abrading the surface of the packing by the twisting motion.

This simple practice of enclosing the packing on all sides is easy enough when pointed out, but the possibilities of it in scientific work were first realized by the French physicist, Amagat, who by the consistent use of it was able to extend by a range of six-fold the pressures which were accessible to science.

There is an essential limitation to the

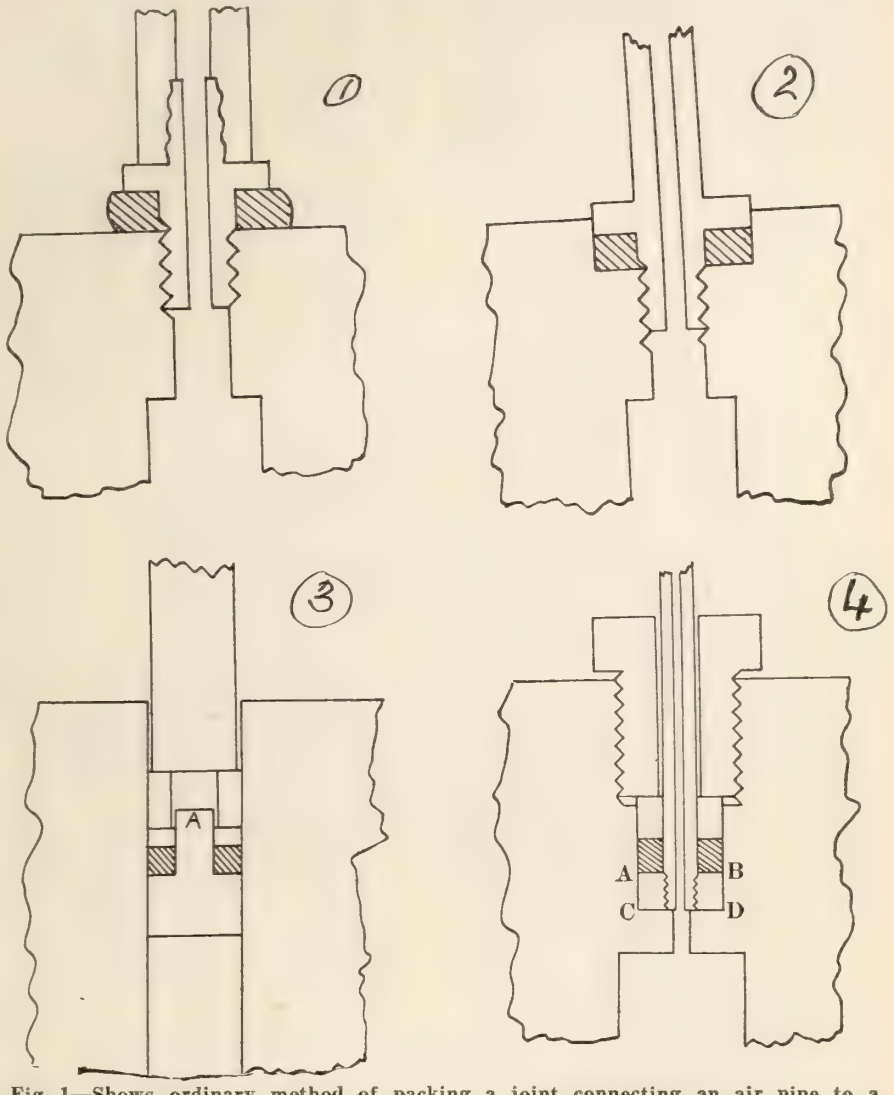


Fig. 1—Shows ordinary method of packing a joint connecting an air pipe to a large vessel.

Fig. 2—Shows a retaining rim around the outer edge of the packing.

Fig. 3—Shows packing on back side of the washer.

Fig. 4—Pressures up to nearly 500,000 lbs. per sq. in. have been obtained with this packing.

pressures that can be maintained by a packing like that of Fig. 2. If at any time the pressure in the liquid rises as high as the pressure in the packing, the packing loses its tight pressure against the walls which retain it, and the liquid leaks past. If for instance, it is desired to pack against a pressure of 200,000 lbs. per sq. in., the screw by which the packing is tightened must be forced tight enough to give an initial pressure in the packing of at least 200,000 lbs. per sq. in. The simplest modification of the packing of Fig. 2 will change all this. Let us put the packing on the back side instead of the front side of the washer at the end of the pipe, as in Fig. 3. We now have a packing that cannot be made to leak by any pressure that the walls of the containing vessels themselves will stand. The application of a little high school mechanics will show the principle underlying the operation. What is it that prevents the pipe from blowing out of the hole? Obviously the pressure exerted by the packing on the ring AB. And what is it that tries to blow the pipe out of the hole? Obviously the pressure exerted by the liquid or gas on the end of the pipe CD. Now, since the pipe neither blows in or blows out, it is obvious that the total force trying to blow it out is equal to the total force holding

it in, or in other words, the total pressure exerted by the liquid over the area CD is equal to the total force exerted by the packing over the area AB. But the area AB is less than the area CD, hence the pressure in pounds per square inch in the packing is greater than the pressure in pounds per square inch in the liquid. The ratio by which the pressure in the packing is greater than the pressure in the liquid is the same as the ratio by which GD is greater than AB.

For example, if the diameter of the pipe is half the diameter of the hole, the area of AB is 3-4 of the area of CD, and the pressure in the packing is 33 per cent. greater than the pressure in the liquid. This excess pressure in the packing is maintained automatically no matter what the pressure in the liquid. If the pressure in the liquid is 1500 pounds per square inch, the excess pressure in the packing is 500 pounds, and if the pressure in the liquid is 150,000 pounds, the excess pressure in the packing is 50,000 pounds. Hence the liquid can never leak no matter how high the pressure, and the only limitation on the pressures that can be carried is imposed by the strength of the containing vessel. The only problem that now remains is the problem of preventing the packing itself from leaking. It is comparatively easy to do this by making the metal washers an accurate fit for the containing vessel, although there are complications at extremely high pressures. It is somewhat paradoxical that if the lower washer is not a tight enough fit, the packing will leak into the containing vessel instead of out, driven by its excess pressure against the pressure in the liquid. It is also somewhat paradoxical that under excessive pressures lead will leak through a smaller hole than rubber. The reason is that rubber becomes rigid, or more properly freezes under pressure, just as a rubber ball loses its elasticity when plunged in liquid air, but the lead is not greatly changed in its properties by the pressure.

The fundamental principle of this packing is that of the unsupported area, in virtue of which the pressure in the packing is always a fixed percentage higher than the pressure in the liquid. In the case illustrated in Fig. 3 the unsupported area is that of the pipe which projects beyond the restraining plug. In Fig. 4 another method of applying this packing idea is shown, this time to the packing for the end of a piston. Here the unsupported area is that of the end of the stem A. With this method of packing the piston, I have reached pressures in liquids up to nearly 500,000 lb. per sq. in. There is furthermore, absolute freedom from leak, so that except for the wearing of the piston the piston returns exactly to its original position after making a stroke. This permits numerous interesting applications in the way of making physical measurements at high pressures.

As illustrating the vagaries of the patent business it is interesting that I failed to get a fundamental patent on this idea because the plunger of a sausage machine had once shown a packing of this character, quite by accident, the peculiar design being for another purpose.

The principle of the unsupported area is capable of the most varied application. Anything may be used as a packing material that is sufficiently soft and flexible. The pressures are so tremendous that even soft steel flows into cracks left unguarded, and in some of my packing designs soft steel rings take the place of soft rubber and function with entire success.

Turning now from the question of the packing, I have observed a number of cases of rupture in dealing with these high pressures which are different from the sorts of rupture usually met with, and which are most instructive. It is strange that apparently the engineer has never determined precisely what it is that makes a material break. He can predict that a rod of steel will break if it is pulled too hard or twisted too much, but quite often he cannot tell in more complicated cases just when a substance will break or in other words, the conditions of rupture are known only for certain special simple cases. The discovery of unusual kinds of rupture is valuable in giving an idea of what may be the conditions of rupture in the general case.

One of the most surprising of these unusual cases may occur to the pipe of Fig. 3. If the pressure in the liquid rises too high, or even if the man with the monkey wrench who tightens the nut is too strong, the soft packing material will be squeezed bodily into the metal of the pipe, which will be pinched off and escape by blowing out through the screw plug. If the pressure at which this occurs is high, the ejection is with great violence, and is one of the chief sources of danger in these experiments with extremely high pressures. I have had plugs blown through eight or ten inches of wood in this way. Such a plug is seen in the first illustration. At the point A the solid steel rod was pinched off by the soft rubber packing. Fortunately the effect does not take place until the pressure in the packing has risen to something about as high as the tensile strength of the steel. Thus a mild steel pipe with a tensile strength of 50,000 lbs. per sq. in. will not fail in this way if the packing is properly designed until the pressure in the liquid has risen to about 50,000 pounds.

The significant thing in this "pinching-off" effect from the point of view of the theory of rupture is that there is no stress pulling apart the fibers that separate. The reason is that the end of the pipe is unsupported, so that there is no force along the length of the pipe. Rupture occurs because the increase of length of the longitudinal fibres of the pipe has become too great. It is exactly like squeezing off a string of putty in the hand. This single example is sufficient to show that it cannot be the force tending to rupture the fibres that is responsible for the break down of material. What then is responsible? It is perhaps the elongation of the fibres? No, it is not this, as we may show by another example, picked from the numerous kinds of ruptures that occur under high pressures. If we make a hard rubber ring with a steel core an exact fit for it, and put the ring with its core into a vessel with liquid, and subject the liquid to a great pressure, we find that the rubber ring is cracked exactly as it would be if it were stretched too much.

Now here is a paradox in more than one respect, for not only is the rubber ring prevented from shrinking by the steel core, so that rupture takes place across fibres in which there is no change of length (or at most a very small decrease of length), but the force in the fibres which rupture, is actually a compression instead of a tension, so that here rupture takes place against the direction of the force. What is then the true answer? It has not yet been worked out, and no one can as yet say exactly what it is that makes a piece of steel break, but curious examples such as these at least show that previous ideas have been wrong and ought to be of much value in suggesting what the correct answer is.

There are other paradoxical effects to be found in the way in which materials rupture under high pressures. Suppose for example that a thick hollow steel cylinder is exposed to pressure over the outside surface in such a way as to tend to collapse it. If the tube is not too thick, it will collapse when the pressure becomes too high by folding in on itself in one or more folds, as a boiler tube sometimes fails. But if the tube has more than a critical thickness, it cannot fail in this way by folding, but must yield differently.

In fact it flows toward the center, so that if the pressure is pushed high enough, we finally squeeze the internal hole out of existence, and have left a cylinder to all apearances that is solid. This will take place at about the same pressure, no matter how thick the cylinder is, which again is paradoxical. If the cylinder is made of soft steel, the hole will be squeezed out of a cylinder with even infinitely thick walls by a pressure of 250,000 pounds per sq. in. Suppose now that instead of trying to collapse a steel tube, we try the same experiment with one of glass. One would be tempted to say that of course the glass tube could not stand as much pressure as the steel one. This is true of a thin cylinder, for a thin glass tube will break into a thousand fragments at a much lower pressure than a steel tube would support.

But if the tube is thicker, there is a complete reversal of behavior and a thick tube of glass will support a very much greater pressure on the outside than will one of steel.

I have subjected hollow cylinders of glass to pressure of 350,000 lbs. per sq. in., without producing any appreciable effect. Yet if a piece of glass is subjected to an ordinary crushing test in a testing machine, it will break at not more than 15,000 or 20,000 lbs. per sq. in.

The essential difference between steel and glass seems to be that the steel is composed of microscopic crystals which can flow under pressure, whereas there are no crystals to flow in the glass, which therefore has no way of yielding, and therefore cannot help but support the pressure. One can see of how much interest these matters are for the geologist, who wants to know whether there are open cavities in the interior of the earth.

I have made similar experiments on various minerals in order to find how these substances may behave in the interior of the earth. Hollow crystals of materials such as quartz will stand a much greater stress without collapse when this stress is a pressure such as that exerted in a testing machine. The figures obtained by the ordinary tests for the strength of the minerals of which the surface of the earth is composed are much too low, and false conclusions are drawn. When a hollow cylinder, such as quartz, does break under very heavy pressure on the outside, the break is of an unusual character. The inside surface disintegrates and flies off into fragments as fine as dust.

These fragments are projected from the interior surface with almost explosive violence, so that if a rod of metal is placed inside the cavity, its surface will be frosted by minute slivers of rock that have been shot into it like bullets. The disintegration of the rock continues until the hole is so tightly packed with debris as to exert sufficient pressure on the interior walls to counterbalance the effect of the external pressure.

Now it is another curious fact that it is never possible to pack the debris so closely that it has the density of the rock from which it came. I have made experiments on rocks up to pressures of 500,000 lb. per sq. in., and have never been able to force the pieces back into their original volume.

This means that minute fissures persist between the fragments of comminuted rock at very great depths, and that it is possible that water or gas may circulate between the fragments and produce important geological effects.

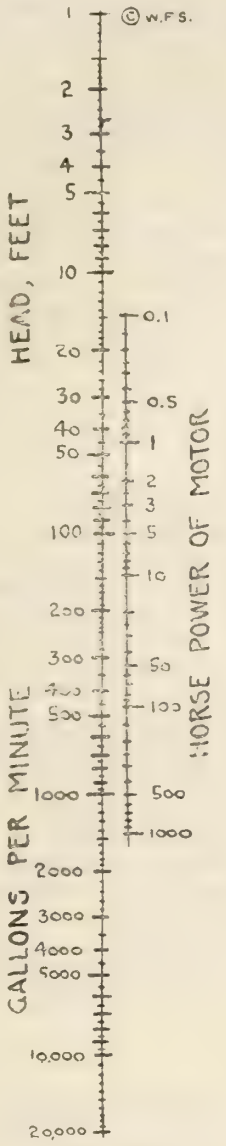
The Pittsburgh, Pa., Experimental Station of the Bureau of Mines is continuing laboratory experiments on coal ash fusibility, oxidizing and reducing atmospheres by the micropyrometer method, and comparing the results with those of the gas furnace. By using a reducing atmosphere in the micropyrometer furnace, fairly good checks were obtained on ash, the average in the micropyrometer method being about 150 degrees F. lower. While the micropyrometer method cannot be used as an alternate method if close checks are required, it can no doubt be used as a rapid method for determining the fusibility of coal ash. The results of this investigation are now being tabulated.

A new investigation, to determine the composition of the gas arising from a fuel bed, is under way at the Pittsburgh Experimental Station.

MOTOR OR ENGINE SIZES FOR PUMPING WATER

By W. F. Schaphorst

This little chart will be found handy for determining the power or size of electric motor to install for pumping. How many gallons do you want to pump



Pump Chart.

per minute? How high or against what head will you pump. This chart gives the answer in a very simple way. It gives the answer under "average" conditions taking into consideration the pump efficiency, friction of water in piping, etc.

For example, what size of motor will it take to pump 2,000 gallons of water per minute against a head of 10 feet?

Find the point midway between the 10 and 2,000 in column A. Opposite that point you will find the answer—9 horse power.

To find the mid-point there are many quick and simple ways. Use a pair of dividers, a ruler, fold a piece of paper, etc.

BOOK REVIEW

We have received from the D. Van Norstrand Company, New York, a copy of "Testing of Electrical Machinery," written by J. H. Morecroft, E.E.B.S., Associate Professor of Electrical Engineering, Columbia University. The book is intended as a short course in the subject of its title for non-electrical students, and is a specially valuable contribution to the literature on this subject, as far as the power plant engineer is concerned. The book is written as a description of a series of experiments beginning with the determining of the fall of potential in a conductor carrying electrical current, the testing of efficiency of various kinds of direct and alternating electrical machinery, the tracing of faults in machines and wiring. It also includes chapters on illumination, and the use and principles of storage batteries. It is a useful book to be in the office of any chief engineer, and is well illustrated by diagrams of the various tests and experiments carried out. There are a set of questions at the end of each chapter.

CATALOGUE

The Pelton Water Wheel Co., of San Francisco and New York, has issued Bulletin No. 17 "Pelton Water Wheels (Impulse Turbines) and Reaction Turbines." The bulletin describes the various types of hydraulic equipment manufactured by the company, and discusses their application both to the generation of hydro-electric power and to the direct operation of many different kinds of machinery. Some space is also devoted to governors and to pressure regulating devices. The bulletin comprises 48 pages and is illustrated by a number of drawings and photographs. Copies may be obtained upon application to either office of the company.

We have received bulletins Nos. 220 and 221 from the Uehling Instrument Co., Paterson, N. J. The first deals with the magnitude of the losses due to the chimney in a power plant, and contains diagrams reproduced from a paper issued by the U. S. Department of Mines. The bulletin No. 221 deals with the relation between CO_2 and the money wasted up the chimney and contains tables of these losses with different kinds of fuels. A set of curves showing the saving by increasing the percentage of CO_2 in the flue gases is also given.

The Bird Archer Co., 90 West Street, New York, have issued a bulletin describing their "Baco" wash out plug, and locomotive type blow off cocks. The latter is fully described and illustrated.

Wallace & Tiernan have issued a bulletin describing their chlorination process as applied to drinking water, which is made in sizes suitable for municipalities or individual plants. The bulletin is entitled "Is Your Own Town on the Map," and gives a map showing the location of their installations in the U. S. and Canada.

A. S. M. E. Code for Compressors and Blowers

The Preliminary Draft of the Test Code for Testing Air and Ammonia Compressors, of Reciprocating and Centrifugal Type, Including Air and Vacuum Pumps, by the Committee on Power List Codes

IN 1918 the Power Test Committee of the A. S. M. E. was reorganized to revise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, consisting of a Main Committee of 25 under the chairmanship of Fred R. Low, and 19 Individual Committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the fifth of these codes to be completed, namely, the Test Code for Displacement Compressors and Blowers.

The Individual Committee which developed this Code is headed by Mr. Paul Diserens as Chairman, and consists of the following men: Hugh V. Conrad, John F. G. Miller, Snowden B. Redfield, Carl G. Sprado, Charles Prentice Turner, and John T. Wilkin. This Committee will welcome suggestions for corrections or additions to this draft of its Code and especially desires constructive comment on Par. 10 and 10a. These should be addressed to the Chairman, care of The American Society of Mechanical Engineers.

Introduction

1. The code for displacement compressors and blowers is intended as a guide for testing reciprocating piston compressors and blowers, as well as rotary compressors and blowers of the positive displacement type. The tables for data and results apply to complete units including compressor element and driving element, but the code itself constitutes a set of rules for the test of the compressor element only. For the driving element the codes for steam engines, steam turbines, internal-combustion engines, water wheels, etc., depending upon the method of drive, should be consulted and followed.

Object

2 In accordance with the "General Instructions," the object of the test should be determined and recorded. If the object relates to the fulfillment of a contract guarantee, an agreement should be made between the interested parties concerning all matters about which dispute may arise, as noted in Par. 2 of the "General Instructions," and the points agreed upon should be stated in the report of the test.

Measurements

3 The measurements to be made in any test of a compressor or blower have for their purpose the determination of the following essential quantities:

(a) The quantity of air or gas compressed and delivered expressed in cubic feet in terms of gas or air under intake conditions of temperature and pressure

(b) The average intake and discharge pressures

(c) The power required to compress and deliver the measured amount of air or gas handled

(d) The amount of steam, electrical energy or fuel, depending upon the method of drive, consumed by the driving element during the test.

In order to arrive at these quantities and as a means of interpreting them, the following measurements are necessary:

(e) Diameter and stroke of compressor cylinders, or equivalent dimensions for positive rotary blower.

(f) Diameter of piston rods

(g) Number and dimensions of intercoolers and aftercoolers

(h) Principal dimensions of driving element (See appropriate code)

(i) Speed in r. p. m. and total number of revolutions

(j) Indicated horsepower in compressor and driving cylinders (steam engine, internal-combustion engine, etc.)

(k) Discharge pressure

(l) Intake pressure

(m) Intercooler pressure

(n) Barometric pressure

(o) Temperature of air or gas before and after each stage

(p) Temperature of cooling water at inlet and outlet of each jacket and cooler

(q) Quantity of jacket and cooling water

(r) Temperatures, pressures, etc., steam, gas or oil as applied to driving element (See appropriate code).

Instruments and Apparatus

4 The instruments and apparatus necessary for the measurement of the quantities enumerated in Par. 3 are:

(a) Gaging tank and nozzle or orifice for measuring air or gas compressed

(b) Tanks and platform scales of suitable capacity for measuring the quantity of condensed steam when a steam engine constitutes the driving element or for measuring fuel oil when an oil engine constitutes the driving element.

(c) Water meters or calibrated tanks, or tanks and platform scales for measuring jacket and intercooler circulating water

(d) Pressure gages, vacuum gages, water and mercury manometers, and thermometers

(e) Barometer

(f) Steam calorimeter (for steam-engine-driven compressor)

(g) Voltmeter, ammeter, wattmeter and power-factor meter for measuring electrical input for motor-driven compressors

(h) Revolution counter

(i) Indicators

(j) A planimeter

(k) A deadweight gage tester

Directions for the use and calibration of instruments and apparatus enumerated above are given in Pars. Nos.—of the code on "Instruments and Apparatus."

4a The measurement of the quantity of air compressed shall be by the following method:

(a) In the case of a compressor or blower: Flow into the atmosphere through nozzle or orifice from a gaging tank on the discharge side of the compressor or blower

(b) In the case of a vacuum pump: Flow from atmosphere through a nozzle or orifice into a gaging tank on the intake side of the vacuum pump.

4b Where the foregoing prescribed method is impracticable, as for example in the case of a compressor handling inflammable gas or gas which cannot be wasted, one of the following instruments may be used. These alternatives are listed in order of preference.

(c) Venturi meter

(d) Nozzle or orifice in discharge line

(e) Receiver tanks of known capacity into which the discharge from the compressor may be delivered, to be used only for compressors working at a discharge pressure of 1000 lb. per sq. in. or greater.

If method (c) or (d) is used, the instrument should be applied in a pipe through which the gas is permitted to flow under a pressure considerably less than the compressor discharge pressure. The reduction in pressure can be brought about by throttling and will result in eliminating, or at least minimizing, the pulsations in flow induced by the compressor.

4c The kind and size of gaging tank and nozzle or orifice selected will depend upon the particular method chosen for measuring the quantity of air or gas compressed. Whenever possible a low-pressure nozzle or orifice shall be used. A low-pressure nozzle is one through which the drop in pressure is small, that is, one in which the upstream absolute pressure is less than twice the downstream absolute pressure. Its use for high or moderate-pressure compressors

Mr. Read approves the draft of the Code as presented with the exception of Par. 10a. He believes that the amount of moisture removed from the separator should be weighed and that this weight should enter into the calculations.

involves throttling the gas before it is admitted into the gaging tank to such an extent that all, or nearly all, pulsation is eliminated. If a high-pressure nozzle is selected, that is, one through which the drop in pressure is relatively large (P_1—$2P_2$), care should be exercised to select an orifice of a size sufficient to insure as much throttling between discharge receiver and the gaging tank as possible.

4d The measurement of the intake and discharge pressures shall be by gage attached at the desired point, the fluctuations of which are reduced as far as may be by choking the gage cock. When extreme accuracy is desired or when the fluctuations are large, the average pressure may be found by working up pipe diagrams taken at or near the same point, thereby determining the mean pressure for the entire stroke.

Preparation

5 Before proceeding with a test of a compressor or blower, Pars. 4 to 8 of the "General Instructions" should be carefully read. The dimensions and physical conditions not only of the compressor but of all the associated parts of the plant essential to the object of the tests should be determined and carefully recorded.

5a Dimensions. The dimensions of the compressor cylinders should be determined by actually measuring the machine itself without reference to the drawings. If the cylinders are much worn the average diameter should be taken, but proper record of the fact should be noted.

5b The method for measuring clearance will depend upon the particular design of the compressor in question. In a reciprocating displacement compressor with valves of the automatic type, the mist satisfactory method will be to calculate the clearance from the measured dimensions of the cylinder, its several ports, and passages. If detailed drawings are available it will be found convenient to check each dimension of the parts involved by actual measurement and from this information compute the clearance volume. If mechanically operated valves are used, or if the construction of the valves of the automatic type is such as to permit blocking them in their closed position, the clearance may be obtained by the water-measurement method. This should only be attempted, however, when extreme accuracy is necessary or desirable. To carry out this method, refer to Par. 5a of the Code for Steam Engines.

5c The area of the compressor cylinder-jacket surface is that part of the cylinder wall or cylinder-head wall in contact with the water circulation and should be measured on the dry side of the metal.

5d The intercooler and aftercooler surface should be measured on the dry side of the cooling surface. Surface in contact with the air to be cooled on the one side and the atmospheric air on the other side should not be included as cooling surface. If a record of its amount is made it should be listed as a separate item.

Operating Conditions

6 As pointed out in the "General Instructions," Par. 19, in all tests in which the object is to determine the performance under conditions of maximum efficiency, or where it is desired to ascertain the effect of predetermined conditions of operation, all such conditions which have an appreciable effect upon the efficiency should be maintained as nearly uniform during the trial as the limitations of practical work will permit.

Tests to determine the performance under working conditions in which no attempt at uniformity is made are not advised, since the only available method of air measurement involves the determination of the rate of flow and total quantities of gas or air must be computed from the observed rate. Unless all conditions of operation are kept uniform or nearly uniform, the results obtained will not be of any value.

Starting and Stopping

7 The compressor should be operated under test conditions for a considerable period before a record of its performance is made. This period should be of a duration sufficient to bring about a steady condition of pressure, temperature and speed. In this connection Pars. 16 and 18 of the "General Instructions" should be carefully noted.

Duration

8 The duration of compressor tests will generally be governed by the requirements insofar as the driving element is concerned, and for direction as to the necessary period reference to the appropriate code governing the driving element should be made. In the case of a motor-driven unit accurate results can be obtained from very short tests, the controlling factor being the time required to record enough sets of observations to demonstrate the uniformity of running conditions during the test.

Record

9 The general data should be recorded as pointed out in Pars. 20 to 30 of the "General Instructions." Instruments should be read and indicator cards taken from each end of each cylinder at least quarter-hourly when the conditions are uniform, and oftener when there is much variation. For short tests referred to in Par. 8, readings and cards should be taken much more often. If there are wide fluctuations in readings they should be shown by recording instruments. Each indicator card should be marked with the number, date, time, scale of spring, and end of cylinder, and on one card of each set the readings of the pressure gages should be recorded. The log should contain the record of the readings of discharge, intercooler and intake gages, thermometers, revolution counter, speed indicator, gaging-tank pressures and temperatures, and all other instruments, and these readings should be obtained at practically the same time the indicator cards are taken. The areas, length and mean effective pressures shown by the indicator cards should also be entered in the log. If complete test data are required, representative pipe diagrams should be taken with an indicator applied near the cylinder port and operated by connection to a reducing motion driven from the engine or the compressor cross head.

9a A set of specimen indicator diagrams should be carefully selected from the whole number taken, and these should be embodied in the record. The specimen cards selected should be such as to show the average conditions of pressure. If pipe or port diagrams are obtained, specimens of these should also be placed in the record.

Calculation of Results

10 Volume of Air or Gas Compressed. The measurement of the amount of air or gas through a nozzle, orifice, or venturi tube results in a determination expressed in pounds per unit of time. (See Code for Instruments and Apparatus, Par.—.) The results obtained must therefore be reduced to terms of volume at the temperature and pressure obtaining at the compressor or blower intake. For this purpose the required specific weight at intake conditions may be calculated from the following formula:

$$\text{Specific Weight} = \frac{P \times 144}{RT} \text{ in lb. per cu. ft.}$$

where P = absolute intake pressure, lb. per sq. in.

T = absolute intake temperature, deg. Fahr.

R = constant (=53.3 for air)

This assumes that the fluid compressed is ideal gas, an assumption quite satisfactory for air. The weight of air or gas per minute as shown by nozzle measurement divided by the specific weight at intake conditions is equal to the volume of free gas or air compresser per minute.

When natural gas is compressed the value R is not nearly enough constant under all conditions to satisfy engineering requirements and a correction must be made, depending in amount on the ratio of compression and the nature of the gas. (See Code for Instruments and Apparatus, Par.—.)

10a[1] Correction for Moisture. In the case of a compressor handling moist air, if some of the moisture is condensed during the process of intercooling and aftercooling, the air under discharge pressure will be saturated. In order to correct the rate of flow as shown by the orifice results it will only be necessary to figure the capacity of the compressor in terms of a total pressure equal to the sum of the partial pressure of air under intake conditions plus the partial pressure of the moisture in moist air having a relative humidity less than that observed in the intake by an amount representing the moisture removed in the cylinders, intercoolers, and aftercoolers. To determine this equivalent pressure to be used in calculating the specific

volume, the following formula may be used:

$$P = P^d + P^m$$

where P^d = partial pressure for air in intake

P^m = partial pressure of moisture corrected for water of condensation and removed from compressor and coolers.

To arrive at the value for P^m, proceed as follows: In the steam tables find the density of steam corresponding to the receiver. Multiply this first by the ratio of the observed absolute intake pressure to the observed absolute discharge pressure and then by the ratio of the absolute temperature in the discharge receiver to the absolute temperature in the intake. The value thus obtained will be a hypothetical density, opposite which in the pressure column of the steam table will be found the desired partial pressure P^m.

It should be noted that the correction for moisture may be properly made only if moisture in the form of condensate is actually removed from the coolers. Care should be taken to make sure that the discharge temperature and pressure used is taken at or near the outlet of the cooler. If no aftercooler is installed the discharge temperature and pressure at or near the outlet of the intercooler should be used in the calculation outlined above.

11 Indicated Horsepower. The indicated horsepower for each end of the cylinder is found by using the formula:

$$\text{I. hp.} = \frac{PLAN}{33{,}000}$$

where P represents the mean effective pressure in pounds per square inch, L the length of the stroke in feet, A the area in square inches of the piston less the area of the piston rod, if any, and N the number of revolutions per minute. The total horsepower of the cylinder is the sum of the horsepower developed in the two ends.

11a The Mean Effective Pressure should be found by dividing the area of the indicator diagram in square inches as determined with a planimeter by the length of the diagram in inches, and multiplying the quotient by the average scale of the indicator spring. If a planimeter is not available, the approximate mean effective pressure may be determined by finding the average height of the diagram in inches as obtained by averaging a suitable number of ordinates, at least twenty, measured between the lines of the forward and return strokes, and then multiplying this average by the scale of the spring. The length of the indicator diagram is the measured distance along the atmospheric-pressure line between ordinates erected perpendicular to it and passing through the ends of the indicator diagram.

12 The horsepower required to compress isothermally the measured quantity of air at average speed on the compressor is found by multiplying the volume compressed per minute in cubic feet corrected to intake pressure and temperature by absolute intake pressure in pounds per square foot and by the hyperbolic logarithm of the ratio of the absolute discharge pressure to the absolute intake pressure and dividing the product by 33,000.

13 The Gross Horsepower is the indicated horsepower in the steam or power cylinders in the case of a steam or internal-combustion-engine-driven compressor; the electrical horsepower multiplied by the motor efficiency in the case of a motor-driven compressor; and the brake horsepower delivered to the compressor shaft in the case of a belt-driven compressor. In the case of a compressor driven through belt, gear, etc., the power absorbed by the belt, gear, etc., must be taken into account.

14 Electrical Horsepower. The electrical horsepower of a motor is found by dividing the input at the terminals expressed in kilowatts by the constant 0.746. In the case of an alternating-current motor, the input determined, whether expressed in electrical horsepower or kilowatts, should be the total input. When the power for excitation or ventilation is taken directly from the compressor shaft, the total input is that indicated at the a. c. motor terminals; but if the motor efficiency as given does not account for the exciter input and exciter loss, the total electrical horsepower (Par. 13) is that indicated at the motor terminals less an equivalent current required to run the exciter.

15 Volumetric Efficiency. The volumetric efficiency is the ratio of the capacity of the compressor to displacement. The capacity is the actual amount of air or gas compressed and delivered, expressed in cubic feet per minute at intake temperature and pressure.

16 Mechanical Efficiency. The mechanical efficiency is the ratio of the air indicated horsepower to the indicated horsepower in the power cylinders in the case of a steam-driven or internal-combustion-engine-driven compressor, and to the brake horsepower delivered to the shaft in the case of a power-driven machine.

17 Compression Efficiency. The compression efficiency is the ratio of the work required to compress isothermally all the air or gas delivered by the compressor to the work done within the compressor cylinder, as shown by the indicator cards. The two factors involved in this ratio are defined in Pars. 12 and 11, respectively.

18 Overall Efficiency. The overall efficiency is the product of the compression efficiency and the mechanical efficiency.

The Data and Results

19 The data and results should be reported in accordance with the tables given herewith, adding lines for data not provided for or omitting those not required, as may conform to the purposes of the test. Unless otherwise indicated, the items should be the averages of all observations.

Table 1 constitutes the data and results applying to the compressing element and Tables 2, 3 and 4 the data and results applying to the driving element for motor, steam-engine and internal-combustion-engine drive, respectively. In reporting a test Table 1 should be combined with its appropriate driving-element table, the two being thrown together to form one complete table. The items of Tables 1, 2, 3 and 4 are so numbered as to indicate how this may be done most conveniently.

Displacement Air Compressor
Table 1 Data and Results of Test on Power-Driven Compressing Element
(A. S. M. E. Code of 1923)

General Information

(1) Date of test .....
(2) Location .....
(3) Owner .....
(4) Builder .....
(5) Test conducted by .....
(6) Object of test .....

Description, Dimensions, Etc., of Compressor

(7) Type of compressor (single or multiple stage, and kind of gas) .....
(8) Type of compressor valves .....
(9) Method of driving compressor .....
(10) Method of volume control .....
(11) Rated discharge pressure ..... lb. per sq. in.
(12) Rated speed ..... r.p.m.
(13) Rated displacement ..... cu. ft. per min.
(14) Rated output expressed in volume (air or gas) at intake and pressure and temperature.. ..... cu. ft. per min.
(15) Type of intercoolers and aftercooler .....

	Intercoolers. 1	2	3
(16) Area of water-cooled surface, sq. ft. ..... See Par. 5.			

	Stages. 1	2	3
(17) Diameter of compressor cyl., in.			
(18) Stroke of pistons, ft.			
(19) Diameter of piston rods or piston rods, in.			
(20) Clearance in terms of piston displacement, per cent:			
(a) Clearance, head end			
(b) Clearance, crank end			
(c) Clearance, average			
(21) Air ratio based on piston displacement:			
(a) 1st stage to 2nd stage			
(b) 2nd stage to 3rd stage			
(c) Total (1st stage to final stage)			
(22) Horsepower constant, air cylinder:			
(a) Head end (stroke × net piston area ÷ 33,000)			
(b) Crank end (stroke × net piston area ÷ 33,000)			

	Stages. 1	2	3
(23) Area of compressor cylinder jacketed surface	sq.ft.	sq.ft.	sq.ft.
(24) Length and cross-sectional area, intake pipe	ft.	ft.	ft.
(25) Diameter of final discharge pipe	in.	in.	in.

Description, Dimensions, Etc., of Compressor Driving Element.
(See Tables 2, 3 or 4)
Test Data and Results.

(40) Duration of test ..... hr.
Average Pressures—
(41) Barometric pressure ..... in. of mercury
(a) Corresponding absolute pressure ..... lb. per sq. in.
(42) Pressure by gage at intake near cylinder ..... lb. per sq. in.
(a) Corresponding absolute pressure ..... lb. per sq. in.
(b) Maximum pressure above or below atmosphere by intake-pipe diagram ..... lb. per sq. in.
(c) Minimum pressure above or below atmosphere by intake-pipe diagram near cylinders. (See Par. 4d) ..... lb. per sq. in.
(43) Pressure above atmosphere in discharge pipe near high-pressure cylinder by gage ..... lb. per sq. in.
(a) Corresponding absolute pressure ..... lb. per sq. in.
(b) Maximum pressure above atmosphere, discharge pipe diagram near high-pressure cylinder ..... lb. per sq. in.
(b) Maximum pressure above atmosphere, discharge pipe diagram near high-pressure cylinder ..... lb. per sq. in.

(c) Minimum pressure above atmosphere, discharge pipe diagram near high-pressure sylinder. (See Par. 4d.) ... ...lb. per sq. in.
(44) Pressure in 1st intercooler by gage. (See Par. 4d) ... .lb. per sq. in.
(45) Pressure in 2nd intercooler by gage. (See Par. 4d.) ... .lb. per sq. in.
Average Temperatures—
(50) Engine-room temperature ... .deg. fahr.
(51) Temperature of air or gas near intake, dry-bulb ... ...deg. fahr.
(52) Temperature of air or gas near intake, wet-bulb ... ...deg. fahr.

	Cycles. 1	2	3
(53) Temperature of air or gas in suction port, deg. fahr.			
(54) Temperature of air or gas in discharge port, deg. fahr.			
(55) Temperature of jacket cooling water inlet, deg. fahr.			
(56) Temperature of jacket cooling-water outlet, deg. fahr.			

	Cooler. 1	Inter-cooler 2
(57) Temperature of cooler circulating water inlet, deg. fahr.		
(58) Temperature of cooler circulating water outlet, deg. fahr..		

(59) Temperature of air or gas in gaging tank at upstream side of orifice ..... deg. fahr.
Total Quantities—
(65) Relative humidity of air or gas at intake of compressor (use Smithsonian Tables) ... ...per cent.
(66) Air compressed and delivered to line ....lb. (See Pars. 4a and 4b.)
(67) Air or gas compressed and delivered to line in cu. ft. at intake pressure and temperature ... ...cu. ft. (See Pars. 10 and 10a.)

	Cycles. 1	2	3
(68) Cooling water supplied jackets, lb.			
(69) Cooling water supplied coolers, lb.			

	Stages. 1	2	After cooler
(78) Cooling water supplied intercolers, lb. or gal. per min. [Item 69÷ (60 × Item 40)]			

Speed—
(82) Total number of revolutions as shown by compressor counter ... ...
(83) Revolutions per minute [Item 82 ÷ 60 × Item 40)] ... ...r. p. m.
(84) Average piston speed ... .ft. per min.
Power—
(85) Indicated horsepower of compressor cylinders, whole compressor ... ...i.h.p.
(86) Low-pressure compressor sylinder, horsepower:
Crank end ... ...i.h.p.
Head end ... ...i.h.p.
(87) Intermediate-pressure compressor cylinder horsepower:
Crank end ... ...i.h.p.
Head end ... ...i.h.p.
(88) High-pressure compressor cylinder horsepower:
Crank end ... ...i.h.p.
Head end ... ...i.h.p.
(89) Friction horsepower [Item 101 (Table 2) or 90 (Table 3)—Item 85] ... ...i.h.p.
Power Input—
(See Tables, 2, 3 or 4)
(102) Gross horsepower per cu. ft. of air or gas delivered per min. at intake pressure and temperature (See Par. 13) ... ... .hp.
(103) Electrical horsepower per cu. ft. of air of gas delivered per min. at intake pressure and temperature (See Par. 14) ... ... .hp.
(104) Indicated horsepower in compressor cylinder per cu. ft. of air or gas delivered per min. at intake pressure and temperature (Item 85 ÷ Item 76) ... ...hp.
Efficiency Results—
(109) Horsepower required to compress isothermally measured quantity of air or gas at average speed of compressor during test (See Par. 12) ... ...hp.
(110) Volumetric efficiency (See Par. 15) ....%
(111) Compression efficiency (See Par. 17) ..%
(112) Mechanical efficiency (See Par. 16) .. %
(113) Overall efficiency (See Par. 18) .....%

Table 2—Additional Items Applying Only When the Driving Element is an Electric Motor.

Description, Dimensions, etc., of Compressor Drive—
(26) Type of motor ... ...
(27) Rated power of motor ... .
(28) Volts ... ...
(29) Amperes . ...
(30) Phase ....
(31) Cycles .. ..
(32) Revolutions per minute ... ...
(33) Typeand rating of exciter ... ...
(a) Volts ... ...
(b) Amperes ... ...
Power Input—
(90) Volts . ...
(91) Amperes per phase ... ...
(92) Power factor (from meter) ... ...
(93) Exciter:
(a) Volts ... ...
(b) Amperes ... ...
(94) Efficiency of exciter (from builder's test) ... ...per cent.

Table 3—Additional Items Applying Only When the Driving Element is a Steam Engine.

Description, Dimensions, etc., of Compressor Drive—
(26) Type of engine (simple or multiple expansion) ... ...
(27) Type of steam valves ... ...
(28) Auxiliaries (steam or electric drive .....
(29) Type and make of condenser equipment ...
(30) Rated capacity of condenser equipment ...
(30) Rated capacity of condenser equipment ...
(31) Type of air pump, jacket pump, and reheater pump (direct or independently driven)
(32) Type of governing apparatus ... ...

	Cycles. 1	2	3
(33) Diameter of steam cylinders, in..			
(34) Stroke of pistons, ft.			
(35) Clearance in terms of piston displacement, per cent:			
(c) Clearance, crank end			
(d) Clearance, head end			
(36) Horsepower constant, steam cylinder:			
(a) Head end			
(b) Crank end			
(37) Area of steam-cyl. jacketed surface, sq. ft.			
(38) Area of interior surface, sq. ft.			
(39) Steam cylinder ratio (overall):			
(a) 1st cylinder to 2nd cylinder			
(b) 2nd cylinder to 3rd cylinder.			

Average Pressures—
(46) Pressure above atmosphere in steam pipe near throttle, by gage . .... lb. per sq. in.
(a) Corresponding absolute pressure ... ... lb. per sq. in.
(b) Maximum pressure above atmosphere, steampipe diagram near throttle ... ...lb. per sq. in.
(c) Minimum pressure above atmosphere, steampipe diagram near throttle ... ...lb. per sq. in.

	Cycles. 1	2	3
(47) Pressure in steam receiver by gage, lb. per sq. in.			
(48) Pressure in exhaust pipe near engine by mercury column .. in. of mercury			
(a) Corresponding absolute pressure ... ... lb. per sq. in.			
(49) Pressure in jackets and reheater ... ...lb. per sq. in.			

Average Temperatures—
(60) Temperature of steam near throttle .. ..deg. fahr.
(61) Temperature of saturated steam near throttle ... ...deg. fahr.
(62) Temperature of steam leaving steam receiver, if superheated ... ...deg. fahr.
(63) Temperature of steam in exhaust pipe as observed ... ...deg. fahr.
(64) Temperature of saturated steam in exhaust pipe corresponding to pressure in exhaust pipe ... ...deg. fahr.
Total Quantities—
(70) Superheat, at throttle ... ...deg. fahr.
(71) Moisture in steam .. ..per cent.
(72) Total steam and water consumed by engine as measured ... ...lb.
(73) Total steam less water consumed ... ... lb.
(74) Correction factor conforming to conditions agreed upon ... ...lb.
(75) Equivalent total steam consumed, conforming to conditions ... ...lb.
Unit Quantities—
(76) Steam and water (or superheated steam) consumed per hour as measured ... .lb.
(80) Steam less water (or superheated steam) consumed per hour ... ... lb.
(81) Equivalent conforming to conditions consumed per hour ... ... lb.
Power Input
(90) Steam cylinder—Indicated horsepower developed, whole engine ... ...i.h.p.
(91) High-pressure steam cylinder, crank end ... ...i.h.p.
(92) Low-pressure steam cylinder, crank end ... ...i.h.p.
head end ... .i.h.p.
Economy Results—
(105) Steam less water (or superheated steam) consumer per i. hp.-hr. (Item 80 ÷ Item 90). ... ... lb.
(106) Equivalent steam consumed per i.p. (Item 81 ÷ Item 90) ... ... .lb.
(107) Steam less water (or superheated steam) consumed per 100 cu. ft. of air or gas compressed at intake pressure and temperature (100 × Item 73 ÷ Item 67) ... ...lb.
(108) Equivalent steam consumed per 100 cu. ft. of air or gas compressed at intake pressure and temperature (100 × Item 75 ÷ Item 67) ... .lb.

Table 4—Additional Items Applying Only When the Driving Element is an Internal-Combustion Engine.

(The items of this table will be developed upon the completion of the Test Code for Internal-Combustion Engines).

BRITISH CONCRETE MACHINERY

At a recent exhibition held in London, a remarkable display of concrete machinery of various kinds was made by a large number of British firms. One of these machines was a concrete block maker capable of turning out 1,000 blocks in an 8-hours' working day, or 130 partition slabs per hour. When used on a house building contract two of these machines turned out on the average of 2,400 blocks per day of 8 hours for a period of two months. On one day the two machines actually produced 3,320 blocks in 8 hours. Another machine designed for making concrete slabs for paving purposes averaged between 40 and 50 slabs in the hour, and has produced as many as 60 per hour under service conditions. A third machine is capable of producing everything in the way of material that a builder or anyone undertaking repairs to property may require. Blocks of various sizes, bricks, window-sills, steps, hearths, mantlepieces, wall-coursing, and so on, can all be produced by this machine.

We have received from Darling Brothers, Ltd., Montreal and Toronto, a bulletin describing the Young Centrifugal Vacuum and Boiler Feed Outfit, which has been designed for operating vacuum heating systems. The apparatus consists of a self-contained unit mounted on a bed plate, which carries the receiving tank, the centrifugal pump, and the motor for driving. Operation is entirely automatic, being controlled from a float in the tank. Vacuum of from 4 to 10 inches is maintained on the system it is claimed by this device.

In the study of the ignition of coal dust clouds in open air, being conducted at the Experimental Mine of the Bureau of Mines, Bruceton, Pa., tests were recently made with pulverized Pittsburgh coal and with pulverized Colorado lignite. In some of these tests flame extended 45 feet into clouds that were 50 feet long, the lignite dust cloud making a larger flame than Pittsburgh coal dust. An attempt will be made to get a greater length of flame with an increased length of dust cloud.

At the central district station of the Bureau of Mines, Urbana, Ill., a study has been made of the inhibiting effect of finely divided fusain or mother coal on the coking property of Illinois coal. Coking tests were made on coal containing up to 10 per cent. 200-mesh mother coal without making any appreciable deleterious influence.

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The Field of Opportunity

A CONTRIBUTOR in this issue draws attention to the possibilities open to the engineer of the present day for the display of individual power and initiation in the power plant, of the modern type. He includes the small, medium, and large plants in his outlook, and gives instances of differences in cost of operation in a number of pulp and paper mills.

While we agree perfectly with him we do not think he goes far enough when he confines the opportunities to the engineer in the modern plant. Frequently the engineer in the more old-fashioned and less efficient plant has better opportunities to make a showing for himself and a saving for the owner than is the case in the highly modernized establishment.

The engineer in the latter plant has usually a high standard to work to, and if he succeeds in keeping up to the standard, that is about as much as he can hope to do, whereas his colleague in the plant where efficiency is only a quality that has been heard of academically, has an immense field for immediate improvement open to him. This is, perhaps, an old theme, but it is one that can bear propagating unceasingly, especially in this country, where the modern efficient plant is still somewhat of a curiosity, and the vast majority of plants are still operated on the hit and miss principle.

The engineer of whatever plant he may be in, large or small, modern or old-fashioned, can only get the best out of it if he is himself equipped with the necessary knowledge to apply to his daily problems, and he can only obtain this knowledge by systematic study. There are still, strange as it may seem, men who take a sort of pride in the fact that they are not bothered with this new-fangled style of education, and stress the fact that they are practical engineers, who learned their business when all these studies were not required.

There has never been a time when these studies were not of value, the only thing is that there has been a time when they were not appreciated at their true value, and a man is none the less a good practical operator because he understands the theoretical side of his work. It is true that this knowledge will the sooner get him out of the necessity of performing the practical work, as he will have the knowledge and ability to carry on the direction of others.

There are thousands of men to-day who are bitterly regretting the chances they had which they were compelled to allow slip by, for the lack of the necessary education. There is no need of any one in these days remaining in that position, for even had they not the opportunity in their young days, there are lots of opportunities open to them to-day to make up for lost time.

It will be only a very few years until every town that can lay claim to the name will have a technical school, and most large towns have them to-day. In addition to these there are all the other sources mentioned in the article, and by no means the least, is the opportunity offered by the gathering together of the engineers themselves in societies for the advancement of their individual and corporate knowledge.

Working At High Pressure

IN ANOTHER portion of this issue of Power House is a description of a means of packing rods to withstand pressures which range from 300,000 lbs. to 500,000 lbs. per square inch. These pressures were necessary for the purpose of scientific investigation, and are such pressures as will never have to be contended with by the ordinary man. However, there may be something to be learned from the methods used which may be applied in part to the ordinary packing problems of everyday life. There is no question about the magnitude of these problems in the engineer's usual routine. There is scarcely a man in the power plant engineering field, unless he is a very new arrival, who has not had trouble at some time or other with a rod, that has defied every effort he made to overcome it.

The friction of packing that is screwed down too hard can be readily understood when we consider it on the light of the paper by Mr. Bridgman, wherein he shows that in the case of the high pressures used by him, the soft packing has actually cut off the steel rods used as plungers. This is accounted for by the fact that the pressure in the packing becomes actually higher than the strength of the steel, and the rod is cut off. Now, when the engineer screws down his leaky gland, on a cylinder where the pressure at the beginning of the stroke is perhaps not more than 115 to 150 lbs. per square inch, he has no idea what pressure he is exerting on the packing in the stuffing box. It may well be that the scored rods so frequently met with are as much due to actual excoriation by the packing itself as to the action of fine jets of escaping steam.

The author brings up the question of what actually causes the breakage of material, and gives instances where the breakage has occurred in a manner directly opposed to our preconceived ideas of the action of metal under a stress.

The action of glass under stress as compared to steel shows some surprising results and from his experiments generally the author deduces some theories which are of interest as to the geological formation of our earth.

While these are perhaps not exactly within the purview of the power plant engineer, they are of interest in themselves, and the article in question will well repay reading by those whose horizon is not limited to the plant in which they work.

The Operators' Point of View

WHAT IS A HORSE POWER?

By M. B. WATSON, M.E.

BEFORE THE above question can be answered exactly it must be understood just what is meant by the word "power." Power may be defined as the rate at which energy is used up in performing work, and this definition requires that we know exactly what is meant by energy and work.

Work is the effect of a force acting through a distance. Thus the British unit of work is the unit of force, the pound, acting through the unit of distance, the foot, and is known as the foot-pound.

Energy is the capacity or ability which a body or substance has within itself of doing work; and is measured in foot-pounds. Thus steam under pressure has a certain amount of energy and is therefore able to do only a definite amount of work, but if the steam is expanded, or allowed to expend its energy, quickly, it will exert a large amount of power during this short period of time; whereas if allowed to expand slowly it will only exert a small amount of power during the longer time but will do the same amount of work as in the first instance.

A flywheel revolving at high speed has a large amount of energy in virtue of its movement. If this movement is arrested suddenly an enormous amount of power is exerted during this short space of time, while if it is stopped slowly only a small amount of power is exerted over the longer time, but the same amount of work is done in each case.

The Unit of Power

The natural unit of power is therefore the amount of work (in foot-pounds) done in a unit time, (the minute.)

At the time of the introduction of the steam engine into commercial work, a unit of capacity was required by which to rate or compare these machines. This unit of capacity of an engine to do work, would naturally be the rate at which it would transform the energy of the steam into mechanical work, and therefore must correspond to some unit of power.

Previous to this the most generally used source of power was the horse, and when more power was required more horses were supplied. Thus the average person of those days could think of amounts of power in terms of the number of horses required to do certain work in certain times easier than in any other units. Accordingly James Watts conducted a series of tests to determine the rate at which a horse could do work. These tests were made on large horses used for hauling railway cars in London, and each test extended only over a short period of time, thus the results obtained were greatly in excess of the rate at which an average horse could do work over a full working day. However, Watts adopted the average of his results as a unit of power which he called the "horse-power," and which he found to be equivalent to 33,000 foot pounds per minute, or 550 ft. pds. per sec. This is the value which we still retain for the mechanical horse-power, and from the above it is seen to be quite arbitrary, for if Watts had happened to use a lighter horse our horse-power would be a smaller quantity, and as it stands it does not bear any relation to the rate at which a horse can do work continuously, although machinery is rated according to its continuous power.

We have then a mechanical horse-power defined as "33,000 foot pounds per minute;" not "33,000 foot pounds" as some people state, the latter being an amount of work or energy.

The units of force, distance and time being exactly defined by Acts of Parliament and International Agreement, we have therefore an exact value for the mechanical horse-power.

The Unit of Heat

Heat is a form of energy and can be converted into mechanical energy, or mechanical energy can be converted into heat. In 1843 and 1850 Joule performed some experiments to find the relation between mechanical energy units and heat units. The unit of heat used in this country is the British thermal unit, commonly written B. T. U., which has been defined by various writers as the amount of heat required to raise one pound of water through one degree Fahrenheit at various temperatures. The definition given as standard for power testing work by the American Society of Mechanical Engineers is: 1 B. T. U.=1/180 of the heat required to raise one pound of water from the freezing point to the boiling point, or through 212-32=180 degrees Fahrenheit. Joule, working with crude apparatus and instruments, found the relation between the above units to be: 1 B. T. U.=772 foot pounds. Recent experiments with more accurate instruments have found this figure to be inaccurate, the value accepted for lower test purposes now is 1 B.T.U.=777.54 foot pounds or 1 foot pound=0.0012861 B.T.U.

Thus a mechanical horse power expressed in heat unit rate is 33,000÷777.54=42.44 B. T. U. per minute, or 2,546.5 B. T. U. per hour.

In electrical work the unit of power is the watt, or the kilowatt=1,000 watts, and the unit of work is the unit of power exerted throughout a unit of time, or the watt-hour, or kilowatt-hour. It has been found that 1 horse-power is equivalent to 745.7 watts or 0.7457 kilowatts.

Thus 1 K.W.=1.341 H. P.=3,415 B. T. U. per hour.

Ratings

Steam engines and boilers, also electric motors are ordinarily rated in horsepower, while electric generators are generally rated in kilo-watts These ratings are supposed to be a measure of the rate at which the various machines will do work and they should bear a relation between the various types of apparatus.

Let us now investigate the method by which these various ratings are determined, also their relation to one another.

In the case of the steam engine the rated power is not the maximum power which the engine is capable of exerting, but it is about the greatest power which the engine will deliver with best economy of steam.

Various formulae have been devised for calculating the horse power of an engine knowing the dimensions of the cylinder; but since the power delivered depends on the speed, boiler pressure, type of valve and its setting, exhaust pressure, etc., none of these formulae give correct results in all cases.

Engine horse-power is measured in two ways. First the rate at which the steam entering the cylinder does work on the piston of the engine. This is known as the "indicated horse-power," or I. H. P., because in order to find this quantity it is necessary to use a steam engine indicator to show the pressure of the steam acting on the piston at each position of its stroke. Knowing the area of the piston and the length of the stroke, we can then determine the total force acting on the piston and the distance through which that force is acting and thus the

power which the steam is exerting on the engine.

The I. H. P. can be calculated by means of the following formula:

$$\text{I. H. P.} = \frac{P \times L \times A \times N}{33{,}000}$$

when "P" is the mean effective pressure (or the average throughout the stroke) of the steam, expressed in pounds per square inch pressure. "L" is the length of the stroke in feet. "A" is the area of the piston in square inches. "N" is the number of strokes per minute (double the revolutions per minute in the usual double acting engine.)

It can be seen in the above that the pressure of the steam acting on a unit area is multiplied by the area on which it is acting, giving the total force on the piston, and the length of the stroke multiplied by the number of strokes per minute gives the distance in feet through which that pressure has acted in one unit of time. Therefore multiplying all these together gives the power in foot pounds per minute. However, since 33,000 foot pounds per minute equals one horse power, we divide the product of the above by 33,000 to get the I. H. P.

The Prony Brake

The simplest method of measuring the output of a steam engine is by means of a Prony brake. Thus the output is rated in brake horse-power, or B. H. P. A Prony brake consists of a shoe or set of shoes, or series of ropes fixed to rub on the flywheel or pulley of the engine and arranged to measure either directly or through a lever the amount of force with which the flywheel trys to drag the brake along with it. Thus knowing this force and the distance the rim of the pulley moves in a minute we can calculate the horse-power delivered.

The B. H. P. is always less than the I. H. P. of a steam engine, because the steam has to supply all the power which the engine delivers, as well as overcoming the friction of the engine

In speaking of engine horse-power it should always be stated whether B. H. P. or I. H. P. is meant. The relation between these two horse-powers of an engine is the efficiency of the machine, the engine giving a greater output for a given input being the most efficient. An engine horse-power however, always means 33,000 foot pounds of work per minute, or 2,546.5 B.T.U. per hr.

In the case of electrical machinery, motors are rated in horse-power, but generators are rated in kilowatts capacity. The reason being that we are interested primarily in the output of the machine, which in the case of the motor is mechanical power, which we are accustomed to think of in units of horse-power; while in the generators the output is electric power which is measured in watts. The horse-power of an electric motor is just the same as that of a steam engine, i.e. 33,000 foot pounds per minute.

Boiler Horse Power

The mechanical horse-power is bad enough, being a purely arbitrary amount, but in the case of boilers we have worse conditions still, the boiler horse-power (so-called) having no reasonable present day relation to a horse-power of 33,000 foot pounds per minute.

Some years ago it was found by experience that 10 to 15 square feet of heating surface in a boiler would develop steam enough to supply a simple non-condensing engine of 1 I.H.P. Boilers are therefore sometimes arbitrarily rated at 1 horse-power for each 10 to 15 square feet of heating surface. If a manufacturer is selling boilers by nominal horse-power, he will likely use 10 square feet per H. P. as this will rate a given size of boiler at a higher horse-power than if he used 12 or 15.

Many government departments use various ratings and relations between heating surface and boiler horse-power for purposes of registration, inspecting and licensing boilers and engineers. The ratio is however fairly high such as 12 or 15 square feet per H. P. in order that no hardship will result to engineers, builders, etc., who have to pay fees according to horse-power of boilers or possess higher qualifications for larger units, etc.

With forced draft and modern engine condensing equipment, boilers have on test supplied steam to engines at the rate of I. H. P. for each 1½ square feet of heating surface. Thus it is seen how far from present day practice are the above arbitrary ratings. It would be more rational to rate boilers according to their heating surface instead of horse-power.

The Committee of Judges in charge of the boiler trials at the centennial exhibition in 1876 realized the inadequacy of such ratings for boiler capacity and for their purposes took the average steam requirements per horse power of the engines of that date. This average was about 30 lbs. of steam per horse-power per hour at 70 pounds gauge pressure. They assumed that the average feed-water temperature at that date was about 100 degrees Fahrenheit. Thus they arbitrarily defined a boiler horse power as the evaporation of 30 lbs. of water per hour from 100 degrees Fahrenheit to dry steam at 70 lbs. gauge. This works out at 33,460 B. T. U. per hour, or about 13 times as great as the mechanical horse-power.

Some years later in order to be able to convert horse power of a boiler operating under certain conditions of feed-water and steam pressure to compare with other conditions, the American Society of Mechanical Engineers defined the boiler horse-power as the equivalent evaporation (or about the amount of heat required to evaporate) of 34½ pounds of water per hour from 212 degrees F. to dry steam at the same temperature. This is equal to 33,479 B. T. U. per hour.

By the adoption of the report of a special committee on power testing in 1915, the American Society of Mechanical Engineers discontinued the use of the boiler horse-power as a unit of boiler capacity, except as a subsidiary unit to convert old data with new; for the reason that it is not a horse-power, and bears no present day relation to one.

Because of the fact that a boiler-horse power as above defined equals 33,479 B. T. U. per hour. and a myria-watt (=10 K. W.) equals 34,150 B.T.U. per hour, or within 2 per cent. of the boiler H. P., Mr. H. G. Stott suggested that the boiler horse-power be made the equivalent of a myria-watt. In view of the fact that a relation of this kind would be of no commercial or practical value, unless in case of evaporating water by means of electric power, or some such unusual procedure, it is difficult to see what good purpose could be served by such a relation.

The writer feels that the action of the American Society of Mechanical Engineers in adopting as the standard unit of boiler capacity "the evaporation of one pound of water from 212 degrees F. to dry saturated steam at the same temperature," is a step in the right direction, as is also the classification of boiler sizes by the areas of their heating surfaces. This would do away completely with the irrational and confusing term boiler horse-power.

In the metric system the horse-power or the "force de cheval" is defined as 75 kilo-gram-meters per second. There is also however, the unit of power called the "poncelet" which is 100 kilo-gram-meters per second. The "force de cheval" is equivalent to 0.9863 horse-power or 2,512 B. T. U. per hour. The "poncelet" to 1.351 H. P. or 3,349 B. T. U. per hour. On account of the difficulty of arranging a brake for very high power, high speed steam turbines, they are generally tested by means of the generator which they will drive, and are often rated according to the output of the combined turbo-generating set in kilowatts instead of horse-power. There is no doubt, however, that the unit horse-power will survive for many years yet and it is therefore well to have an exact knowledge of what is meant by a horse power.

DOMINION WIDE CERTIFICATE

The Editor,
Power House.

In reply to J. W. C.'s letter in January 5th issue on the Dominion Wide Certificate, in which he says a verbal examination should be sufficient without the need of confirmatory references, I do not agree with this. If this were the case a man could attend a technical school for four years and then pass for a first-class. I say and know that such a man could not even fire a boiler and would not know what a good fire was unless he had practical experience.

Let them start like I have done in the boiler house with the shovel and save their time. I have passed all exams and hold a first-class Certificate for Ontario and I started from a third class. I think a copy of the regulations for examination of engineers should be sent to him and he will see that they have to have six months in the boiler room before they can write for

fourth-class, and then one and-a-half years for third-class, two years more for second-class and five more for first-class. If a candidate has not enough experience by then he never will have. I did, and never attended a school for engineers of any sort.

The only thing I see wrong with the graded papers is that they are about eight or ten years behind in being brought into effect. Wishing "Power House" success.

S. A. W.

The Editor,

Power House.

Permit me to express my opinion on the Dominion Wide Certificate, as I have read with great interest the many comments on this subject. The idea is a fine one, if the law would be carried out properly. I cannot say as to the other cities in the province, but I can say here that in the Twin Cities of Port Arthur and Fort William, the law is not being carried out at all.

At the present time there are a number of plants being operated by uncertified men, while there are a great many men with certificates walking the streets. I would like to ask if it is necessary to report these violations to the Board of Engineers, or can these violations be handled here by our own city authorities? What steps would be considered necessary to have the law carried out?

Hoping you will find space in your valuable paper for this letter, and trusting to see a Dominion Wide Certificate.

E. J. M., Port Arthur.

The Editor,

Power House.

I have been following with great interest, the different views given upon the subject of a "Dominion Wide Certificate."

On pages 38-39 of your January 5th edition, Mr. J. W. C. expresses his opinion that the lower grade certificates, i.e., 4th and 3rd class, are not worth the paper they are written on. This may be correct, but do you not think that to a young man starting out, a 4th class certificate and later on a 3rd gives him great encouragement to go still further? Does it not encourage him to study to attain higher things? Not many things in this world are obtained in one jump. They must be gotten one step at a time.

Throughout Canada there are thousands of 4th and 3rd class engineers. Supposing these men were to find themselves without a certificate many of them would throw up engineering in disgust. I am speaking of those who are working and studying and doing their greatest to forge ahead.

In my opinion the obtaining of a "Dominion Wide Certificate" would be one of the best things for the advancement of Canadian engineers that could happen, but why not let there still be grade certificates, viz.: 4th, 3rd, 2nd and 1st?

There would be no chance of a 4th class engineer taking a 3rd's or a 3rd taking a 2nd's position if the rules were rigidly enforced by law.

What would happen to the thousands of 4th and 3rd class engineers, or those who would remain with the profession? They could take a firing job or oiling and obtain on leaving, a reference relating to their time served and good workmanship, but a reference is not so good as a government certificate. An employer or chief engineer will often give a man references who does not deserve them, simply because he, the chief or employer, thinks that it will do him no harm anyway. No, but it sometimes does the next employer harm.

A certified engineer could blow up or cause to be blown up, a boiler or do other very serious damage, but he would in all probability lose his license, nor would he again be allowed to take out another in Canada. On the other hand an uncertified man could do the same damage and get away with it. All he would have to lose would be his references at that particular position. He goes somewhere else, shows his older references, gets another job; and finishes his time, thus, after passing the examinations becomes a certified engineer.

Would this not be more dangerous than having employers and employees both protected by a certificate, even as low and worthless as the 4th class?

Engineering in Canada need not deteriorate because there are four grades instead of two

By all means let the examinations be stiffer, so that the first-class engineer has to pass an examination equal to that of the Board of Trade Certificate. The other three grades could be as hard in comparison.

H. W. W., 4th class,
Vancouver, B. C.

The Editor "Power House:"

In your issue of January 5th, I read with interest a letter signed by "J.W.C." and being of the same cloth as himself namely possessor of a British Board of Trade Certificate (1st class) but with this advantage that I also hold an Ontario Certificate (1st class) perhaps a few friendly criticisms on his egotistical remarks would not be amiss.

In the first place he makes the statement that if he cared to, he could have half a dozen certificates. I don't know to which province he refers. It certainly isn't Ontario where any engineer can tell him that one is the limit and all that is necessary to a stationary engineer.

He also states that he considers the certificates are not worth the paper they are printed on, as he knows them. I am afraid his knowledge is limited in that respect, limited to coaching firemen. I would like to see Mr. J.W.C. take charge of a plant "of any size" in Ontario without the necessary certificate. When I say "of any size" I mean a plant which requires an engineer to run it, not a fireman's job, or a plant where there is an argument as to whether it is large enough to come within the scope of the Act, or not. He would then find if the certificate was worth the paper it was printed on, provided that said plant was within the bounds of civilization and not up in the bush somewhere where it required an aeroplane to locate it.

J. W. C. lauds the value of a British B. of T. certificate to the skies, then suddenly pulls it down again by recounting his experience on board ship, whereby his chief (1st class certificate) was severely reprimanded by the super which is the experience of various boards of examiners through the province, and especially the Ontario Board. So many men with 1st class British B. of T. certificates fell down on 1st class Ontario examinations, that it was decided to let them write 2nd class, first, then if their papers were satisfactory they could go ahead with the first-class examination, provided of course the man had the required experience. A condition which I do not think unfair, taking into consideration the fact that a 1st-class Canadian certificate is not honored by the British B. of T.

J. W. C. must remember that a marine engineer's job is entirely different to that of a stationary engineer in a big plant. One is a revolution expert and the other is a C02 expert. One is fighting for revolutions and does not worry himself about trifles like furnace temperatures, or the efficiency of his boilers with regard to coal consumption, the other does, it's so many pounds of manufactured products coming out at one end of the factory to so many pounds of coal going in at the other. And there is a mighty big difference between these two engineers' jobs.

A British B. of T. certificate is only "good the world over" where British shipping is concerned, and a chief who spent his life on a 3,000-ton tramp, would no sooner expect his certificate to get him in charge of the "Olympic" than he would expect it to take him a joy ride amongst the clouds. So much for the face value of the British B. of T. certificate.

A verbal recommendaton of a man's own ability would be pretty poor dope for an examiner to work on these days. When taking it easy something more tangible than that is required. J.W.C.'s remark that one certificate should cover everything, I don't think feasible. You find "local conditions peculiar to themselves" in one province let alone the whole Dominion.

Of course we all know that things are done differently in the "Old Country;" they always were and always will be, another "condition peculiar to itself," but taking into consideration the age of Canada as a country, and the length of time these license laws have been in effect, you must admit that things are going pretty good, and if you expect every engineer in Canada to start with a 5-years' apprenticeship as a machin-

ist, well I am looking for the millenium. J. W. C. explains that he is not trying to compare the British B. of T. certificate with the Canadian one. If his whole article in that issue does not point that way, you have got to show me.

My experience has been that a great number of engineers prefer even more localized certificates than those already in existence, something on a par with certain parts of the States where they themselves would control positions vacant in a town or city.

W. J. S.

Editor's Note

This comparison of the British B. of T. certificate with the Ontario or any other provincial certificate is beside the mark, and gets no one anywhere. The question is merely whether it would be preferable to have a certificate issued by the Dominion authorities or by the provinces.

As a holder of a Board of Trade certificate (Extra First Class) I see no reason why a man that holds the Board of Trade first-class certificate should not be able to pass any provincial examination. However, it seems that there have been cases where such men have failed. There are no doubt good reasons for these failures if they could be traced. On the other hand there are men holding the first class Ontario certificate who could not pass a second-class Board of Trade examination.

When I came to this country I first settled in Montreal, which at that time issued its own licenses, in four grades. I merely asked that I be allowed to sit for the first class examination on the strength of my experience and the certificate I held, and that privilege was granted me. Some years after I sat and passed the examination for boiler inspector for the province of Quebec. If it were necessary for me to hold a certificate in Ontario I would ask the privilege of sitting for the first class examination, not on the strength of my B. of T. certificate but on my experience in Canada.

My own opinion is that a man with a first class B. of T. certificate should be allowed to sit for a first class certificate in whatever province he finds himself. I would not ask for any special privileges for such a man, but on the other hand he should not be handicapped, because he is a B. of T. man. If the man presenting himself is really the possessor of a first class B. of T. certificate it is evidence that he has served a five years' apprenticeship, not as a machinist, but as a builder of engines, and that he has also had from 2 to 5 years' experience of operating engines under far more exacting conditions than ever occur ashore. On that evidence he is entitled to at least the same consideration as the man who has graduated from the stokehold.

My argument for a Dominion certificate is that its adoption would remove all these local prejudices, and give every man the same standard of qualification all over the Dominion. I have constantly pointed out that the certificate does not make the man, it merely is an attestation of a certain minimum standard of knowledge.

There is no equality in nature, and the man with the better ability will rise inevitably. All that those of us who favor a Domininion certificate wish, is that every one should get the same start.

T. H. F.

THE STATIONARY ENGINEER AND HIS OPPORTUNITIES

Don Mack.

The field of endeavor before the stationary engineer in charge of the modern small, medium or large sized power plant has broadened wonderfully and gives a scope for individual usefulness and the introduction of economies that are hardly realized by many of us.

To illustrate, let us consider figures taken from the records of a recent convention. Ten paper mills were investigated, situated in different locations but all making the same grades of paper. The total cost of steam per 1000 pounds was 47 cents in the lowest and 91 cents in the highest. The cost of the item of coal alone varied but little more than 25 per cent. between the various mills. This, however, is but a small part of the total variation between the highest and the lowest. Special local conditions may be taken as causing a variation of 30 to 40 per cent. between the various mills, but since the highest cost exceeds that of the lowest by over 90 per cent., there is still left a large margin for investment and possible reduction.

While such study is usually allotted to the professional, consulting power engineer or specialist, there is evidently a vast field of opportunity here for the operating engineers and the members of their staffs who are in daily contact with the actual production, distribution and application of power in these plants.

In one of these mills, the power required per ton of paper produced is being reduced from 31 to 18 H. P., through a correct application of the power and a change in the process of manufacture of the product. In this case, the results are due to co-operation between those in charge of the manufacturing departments and the power plant engineer, but they are indications of the almost unsuspected opportunities for improvement which exist in more cases than most of us are usually willing to believe.

In another instance, in a plant of 12,000 K.W. capacity, each one per cent. of added efficiency over and above the ordinary development meant more than $5,000 per year saved. This, however, was a hydro-electric plant, and one per cent. in a steam plant of similar capacity would probably mean a much larger saving in dollars and cents. It is evident that in the small as well as the medium and large sized plants, fractional percentages of saving are worth while striving for and will aggregate amounts sufficiently large to compel recognition by the management of those whose efforts have been given to securing such results.

The opportunities and means available to the stationary engineers of to-day for study and self-improvement along the lines of their work are beyond doubt more numerous than ever before, and at the same time they afford a more advanced and a more thorough training than in the past in the principles and practice of the generation and handling of steam power, electricity and the production of refrigeration, compressed air, etc., as well as other lines of work with which the present-day stationary engineer is expected to have some familiarity and for the economical performance of which he is often held responsible.

The trade and technical journals, the various courses of the correspondence schools, library extension arrangements, special courses in technical schools, etc., are all facilities ready to the hand of the progressive stationary engineer who has caught a glimpse of the possibilities for greater usefulness through self-training, and who forges ahead, realizing that there is no limit to his field.

SOME CONDENSER NOTES

By J. W. Carruthers

The Editor,

Power House.

There is no one who looks forward to the issue of the "Golden One" more than I do. The articles are so helpful and the letters very interesting and especially the Questions and Answers, which I find are great fun and incidentally good practice for anyone in trying them out. There is one thing that I have particularly noticed, and that is in the description of the various plants, generators and turbines are described in detail. Switchboards and all auxiliary apparatus are explained, even the size of the various buildings and the old crane up overhead is not forgotten, and then we read in a very small paragraph that the turbines are coupled up to surface condensers, capable of handling so many thousands of pounds of steam per hour. Such an important piece of apparatus as a condenser in a turbo-driven plant is surely worthy of more consideration, than a mere assertion that such a thing exists there. I have failed to find any book, (if there is such a thing,) on surface condensers and the practical handling of them outside of the usual makers' pamphlets, and I may say that I have as good a library along the usual lines as anyone. A few notes, therefore on condensers may not be out of place.

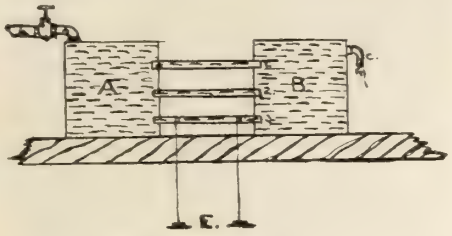
I do not think that there is a piece of apparatus in the engine room that requires more careful handling than does a condenser, and anyone knows that a careful manipulation of various valves greatly increases the efficiency of the set for obvious reasons. On the other hand any "manhandling" of these same valves, quickly leads to trouble, as was the case in a plant not a hundred miles from here. It was the custom in this plant that when any of the assistant

engineers were sick or off for any reason, for one of the repair men to take his place pro tem. While this young man was being "broke in" to the job by one of the assistants, it was particularly impressed upon him, that by throttling back the intake circulating water, the result would be a higher temperature of the condensate, which was always a very desirable point. The assistant, perhaps, forgot to mention that there was a limit to this throttling and that the vacuum carried would determine the amount. Some considerable time after, this same young man was on duty in the engine room, and about half an hour after he came on watch, the chief asked him, "How were things going?" "Great!" he said, "that so-and-so thermometer is coming up gradually since I came on."

After the chief had got things back to normal, he explained to him that it was the condensate and not the outgoing water that had to be kept high. It is only fair to mention, however, that he had got the thermometers mixed up, and had forgotten which was which.

Pitting of Tubes

For some considerable time we had trouble caused by the pittings of condenser tubes and the consequent leaking of same. On several occasions we have had to renew from twelve to twenty tubes at a time. This was an expensive operation considering the time taken for renewal and putting the condenser in working order again. The most important point, however, was that if anything should have happened to the unit then in service, it would have meant a complete shut down of the plant, our plant, then only consisting of the two units. In view of this several experiments were carried out, to determine what would be the best method of procedure under the existing conditions. Various theories were deduced such as, salty circulating water, galvanic action, chemical action, bad class of alloy in tube material, etc. About this time our Super came into the engine room one day with a copy



Test Arrangement

of the report of Messrs. Bengough & Jones', "Contributions to the History of Corrosion."

These gentlemen are I believe, experts in this particular line of endeavor, and the experiments they carried out to determine the above, are explained very clearly. Our Super told us to go to it and find out things. I have, unfortunately never seen this report in English, my copy was in French, so that the task of finding out things was even more difficult, only having had a nodding acquaintance with French. I have often read and seen these reports referred to in the technical press, so I take it that these gentlemen are masters of their craft. I shall quote them as authorities and herewith I acknowledge the source of information.

Experiment on Corrosion

Galvanic action was the base line on which we conducted our experiments. I might state here that our plant is situated on a tidal river, which is fresh low water, and salty when the tide is high. To determine the action of our circulating water on the tubes, we made out of old tins, an apparatus as per sketch. A is a tank which is connected by three tubes to a similar tank B. Circulating water is tapped from the condenser delivery pipes, falls into A, passes through the three tubes into B. and overflows at C. Tube No. 1 is a piece of unused condenser tube; tube No. 2 is the same, but tinned on the outside; tube No. 3 same as No. 1 but "earthed" at both ends.

This apparatus was kept in service for five weeks, after which the tubes were examined. It was found that tube No. 1 showed slight de-zincification; tube No. 2 also showed some signs of the same action, and tube No. 3 did not show any deterioration whatever. To make sure that such was the case, tube No. 3 was split from end to end, and examined with a magnifying glass, and

Result of an Enquiry into the Cause of the Corrosion of Condenser Tubes

Industry in which tubes are used.	Duration of service of corroded tubes.	Normal service of tubes, years.	% of tubes rejected in time of 2nd Col.	Length of tubes, Meters.	Position of the corroded region in the length.	Position of tubes in condenser.	Temperature Max. and Min. of Cir. W.	Ships; are they electrically lighted?	Protective measures.	Duration of trial.	Suffiecd causes of corrosion after tests.	Nature of damage done.
Paper Mills	9 weeks	6 to 7	1¼	2.41	607/1 from Ent. water	Top	Tidal	.....	.....	Continuous	Not known	De-zinc. and pitting.
Spinning Mills	4 years	7	—	..	Middle	Where steam enters.	24° to 29° fresh	.....	.....	11½ hrs. per day	Acidity of water	Pitting
Power House	2 years	5	4	2.48	At the Ends	Ditto	Fresh	.....	Iron electrodes	Variable	Bad quality of tubes	De-zinc. and Thinning
Flour Mills	2 years	4	8	2.53	Middle	Ditto	Fresh	.....	Zinc electrodes	Variable	Ditto Adhering globules of CO_2	De-zinc. and pitting
Ships in Tropics	7½ years	15 to 20	5	3.90	Middle and Ends	Top	43° to 46°	Yes ship return	Iron electrodes	12 Days	Impure alloy	De-zinc. and pitting
Ships in Tropics	2½ years	7 to 10	1.6	3.73	Near ent. Cir. water	Top	21° to 43°	Yes, Double wired	None	.....	Metal of bad qual.	De-zinc. and pitting
Ships General	3 years	7		4.00	On whole length	Top	38°	No	Casing covered with cement	Variable	Careless fitting galvanic action	De-zinc. and pitting.
Ships Home Waters	6 years	12	50	3.73	Ends	Bottom	32° to 39°	Yes double wired	Zinc electrodes	Several hours	Not defined	Thinning and pitting
Ships Atlantic	11 years	11	Large %	4.16	Ends	All over	38° to 46°	Yes ship return	Zinc electrodes	8 days	Retarding of Cir. water	De-zinc. and thinning
Ships Atlantic	3 years	—	3.5	3.75	Middle	All over	32° to 42°	Yes double wired	Method Harris Anderson	.....	Not defined	De-zinc. and pitting

as far as could be determined, this tube was in good condition. The three pieces of tube were cut from the same piece of condenser tube.

It might be observed here, that the apparatus as shown, does not show exact condensing conditions. This is true of course. The idea was to find out the action of the salty water on the tube alloy according to the well known law of Volta. The damaged tubes always show the de-zincification as beginning on the inside (water side) of the tubes, and not on the outside, (steam side.) It was therefore deduced that the galvanic action would show up with the above apparatus, provided that similar tubes were used with the same circulating water. That this deduction was perfectly correct seems to have been proven according to the tests made. If then, the fact of tube No. 3 being "earthed" afforded some protection, then we must "earth" our condensers. This we carried out by "short-circuiting" both condensers with ½ inch copper trolley wire. During our experiments we found that a heavy current was leaking from a nearby street railway system. This was remedied, as far as possible, by re-bonding the rails in the vicinity of our plant. After some time had elapsed it was found that an improvement had been effected by our trolley wire "earth," and to further arrest galvanic action, zinc plates were fitted in front of the tube headers and the heads themselves painted with a non-corrosive paint.

Messrs. Bengough & Jones tabulate the results of their enquiry into the cause of the corrosion of condenser tubes, in the form of a table, which is here copied complete as it contains quite a lot of information. It is to be noted, that lengths are in meters and the temperature centigrade. In a resume of their tests and to use their own phraseology—they say:

There are two sorts of corrosion, total corrosion, which attacks all the constituents of the alloy and is particularly active under normal temperature of the atmosphere. Partial corrosion acting only on the zinc. This partial corrosion must be considered as an inherent property of an alloy which is made up of zinc and copper under certain conditions of temperature and in salty water.

The brass alloys that best resist complete corrosion on the other hand offer the least resistance to partial corrosion. On the other side the protection brought about by a deposit of carbonate of lime, by galvanic action has been clearly brought out. There are four methods for practically preventing the eating away of the zinc as follows:

1. Employment of pure water for circulation.

2. Substitution of brass of a different alloy.

3. Working the condenser at a convenient temperature for the particular alloy in use.

4. Galvanic protection.

No. 1 is impossible for ship-work and is also in the most of cases equally impossible in land installations. In considering No. 2 there are several points. A brass can evidently be manufactured with a modicum of zinc, but by doing so exposes it to effects of another order. Phosphor bronze is subject to complete corrosion "Monel" metal, (copper and nickel) give the best results, but it is expensive. It is suggested that an alloy of copper and aluminum is as good and does not cost so much, but it still has to prove its efficiency.

In all cases of the alloys actually employed, the best was found to be the alloy as used by the British Admiralty, viz.—copper 70 per cent., zinc 29 per cent., tin 1 per cent. No. 3 is of particular attention to engineers. The temperature of the metal can't be lowered, because this limits the weight of steam condensed by unit surface. Shortening the course of the circulating water or by increasing the loss of the water, and keeping the tubes clear of obstructions by frequent cleaning, it is necessary to employ a filter where the water enters the system. The ratio between the weight of steam and the surface is chosen for the existing conditions without having any regard for corrosion. The use of baffle plates for the better distribution of the water over the whole length of the tubes gives favorable results.

Considered from the corrosion point of view it is better to give the water a double course and it is advisable to divide the condenser up into compartments, having an entry and an exit for each compartment. The ordinary velocity of circulating water is from M1.20, to M1.80 per second in marine installations.

It is best to adopt the higher velocity if possible. The tubes are not generally corroded if found near to the entering steam. This action is not due to foreign matter, but is, as has been demonstrated, due to the higher temperature of the tube at this point.

A Clearance Indicator

By J. C. Crichton

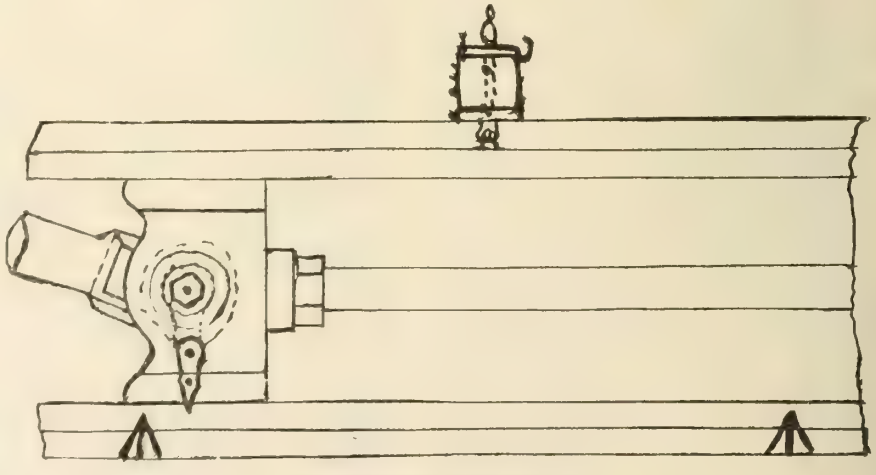
RECOGNIZING the long-felt want for a reliable method of checking up the clearance that a piston has inside a steam cylinder, I set my thinking cap on at the right angle with the result that I have made a small attachment which I term a clearance indicator.

I have been in charge of different plants with numerous engines scattered all around the plant, each one making more noise than its neighbor. Thinking possibly the clearance might be all at the one end, and the other end being pounded by the piston, I would proceed to equalize the clearance by adjusting the connecting rod. But when I would examine the crosshead and guide bars for bumping marks, I would find that every engineer that ran the engine must have put his own bumping marks on. The result is that you can't make any conclusions for the safety of the engine without disconnecting the rod and making another set of marks.

Then again if engine is fitted up with adjustable slippers, and bumping marks are put on, when they are set up the adjustments are all gone.

This attachment that I have made obviates all these difficulties, and when once put on an engine it is there for good, and remains to be seen by every engineer that comes on the job. I think if this attachment were adopted by engine builders and put on at the factory it would settle the adjustments once and for all and save mutilation of good engines. I have enclosed a sketch which will show the operation of indicator.

In the plant I am operating at present I have three engines with indicators fitted on and different engineers who have seen them enquired why didn't the engine builders put them on and save lots of worry to the operating engineer. The indicator could be made either in brass or steel and could have maker's name on it, also size of engine.



The Clearance Indicator

Renewing a Large Engine Bearing

By D. A. Hampson

A GREEN engineer in a power plant let the oil get completely out and succeeded in burning the lower half of one of the main bearings. The engine was a Ball & Wood cross compound and the main journals were 11½in. by 21in. It took the crew a couple of days to disassemble and jack up the parts so the bearings could be removed. Then it was found that the cap and the two quarter blocks were unhurt and it was only the bottom member that had to be renewed.

It was an open question whether or not to return the pieces to the factory or have a local shop do the work. Finally a decision was made in favor of the latter, because of transportation uncertainties. Our shop got the work as one best equipped, though no one locally had ever attempted a job even half as large as this one, therefore the methods followed may be of value to others in similar breakdowns.

The first move was to get the burned babbitt out of the shell. This piece, weighing about two hundred pounds, was blocked up on bricks out in the yard, setting it an angle of about 40 degrees. Thus arranged, it was possible to build a wood fire under the casting to melt out the babbitt and to catch the liquid metal as it ran out. A boy did this and had the shell clean in two hours. The old babbitt was not considered fit to put in again but was saved for unimportant work.

Shell Turned on End

Our original intention was to pour the new metal with the shell lying in its natural position, using a turned mandrel supported on parallels at a proper height at each end, and we had intended to make our mandrel out of a section of a telephone pole but we found no pieces that would answer, so had to give up that idea. The alternative was a better scheme anyway; a piece of 1-16in. sheet iron was cut the size of the face of the shell, concaved through the centre to a slightly smaller radius than the journal, and secured to the shell by "C" clamps. Then the shell was turned on end. Pouring such a bearing on end always leaves a denser, cleaner lining of the kind that shows up free from lines and holes when bored.

No ladles were available larger than the small hand type that hold about 50 cub. in. of metal, and we had to provide eight times that amount. An ordinary household iron kettle of the kind whose diameter about equals its depth, and having, besides a good bail, a ring on one side for tipping, took the place of a ladle.

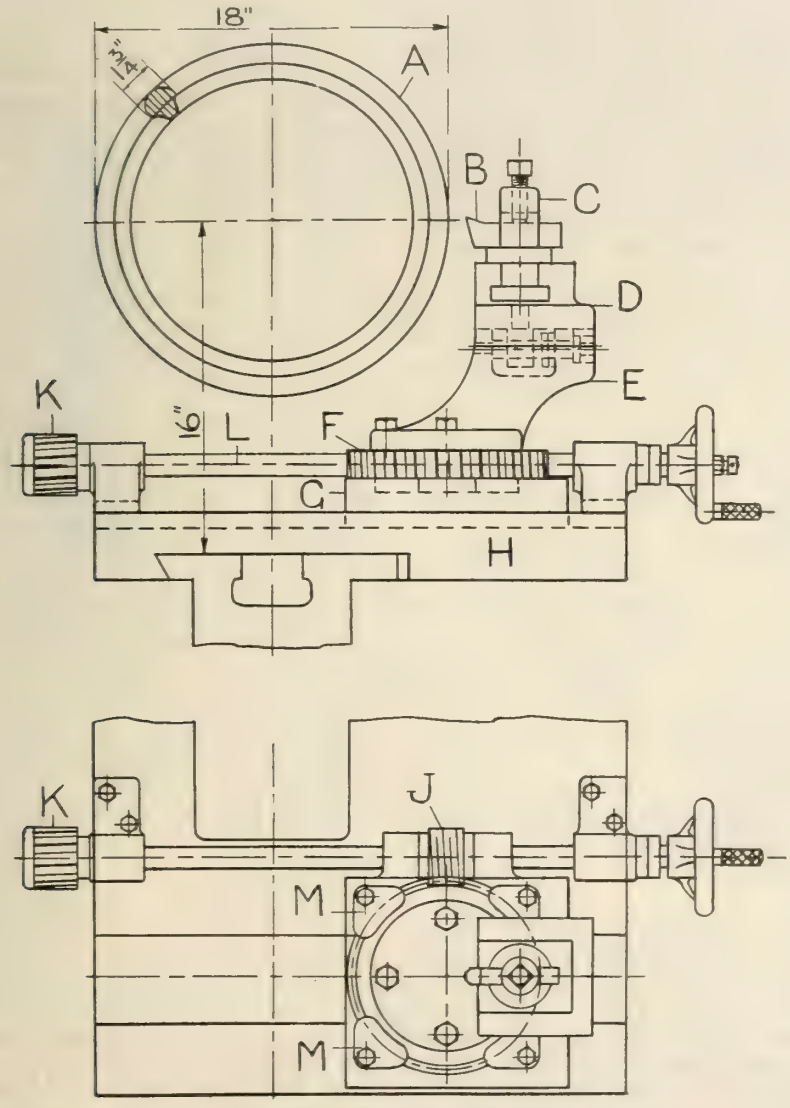
The metal was heated in the forge, near which was placed the shell standing on the concrete floor and having a good riser built up on top. A more perfect job than this equipment turned out would be hard to find. Before the babbitt had entirely cooled, workmen started to peen it, going over the entire surface and hammering the metal to a greater density and making it tighter than ever in its grip on the undercuts.

Boring Operation

Boring was the most particular of the jobs involved. We had a lathe with flaring wings on the carriage. These were "T" slotted, and we had "T" slotted parallels that we bolted to these wings to form a work table for various boring jobs. A 3in. boring bar was available, though we had to make a special tool to reach the large diameter.

It was decided that a better job would result if the three other parts of the bearing were skimmed out at the same time, removing just enough material to clean the surface. In setting up, the bottom shell was first lined up with the bar and placed at the correct height and clamped. Then angle plates were bolted to the parallels at each side of the bottom shell, forming a skeleton opening similar to that in the engine frame. The quarter blocks having been shimmed and bolted, the cap was clamped on and boring commenced.

Little remains to be told. Chipping the oil grooves was the most tedious job of all. A splendid fit and equal alignment were obtained. Three days after the parts were laid down on our floor, the work was finished. Probably the factory wouldn't have bettered this much. The babbitt used was purchased from the street railway, of a grade put out for motor bearings, and seemed well adapted for this other work.



Details of the carriage of lathe.

Babbitting motor bearings is described in detail in circular reprint No. 104, published by the Westinghouse Electric Mfg. Co., East Pittsburgh, Pa. The publication is a discussion of the production of babbitt metal by J. S. Dean, of the Railway Motor Engineering Department, and contains a number of photographs of equipment used in the manufacture of babbitt metals as well as the results of various tests of samples of alloys.

The Hydro Electric Power Commission 43 Hughson Street, Hamilton, Ont., will erect an electric station on Ottawa St., at a cost of $100,000.

C. A. S. E. Competition Questions and Answers

Question:—What shape of chimney is best? Give reasons.

Answer:—Round, because it offers less resistance to the passage of waste gases which ascend in a more or less spiral movement; whereas in the case of a square chimney, this spiral movement of the gases would set up eddy currents in each of its four corners thereby increasing the resistance.

Question:—How is the draft pressure usually measured?

Answer:—Chimney draft is usually measured with draft gauges which indicate the equivalent of water in inches, or fractions thereof, displaced by counterbalancing atmospheric pressure.

Question:—What is the correct distance between the top of the grate and the bottom of the shell in the H. R. T. boiler; also why is the distance not standardized for different boilers?

Answer:—For H. R. T. boilers it is considered good practice to have the distance from the top of the grate to the bottom of the shell at least 48 inches, varying same according to the size of boiler and furnace and the kind of fuel. For water-tube boilers it is considered good practice to have the bottom row of tubes set at least 6 feet above the grate; however, there is a tendency, because of overloading ratings and the use of long flame coal, to set them much higher. Standardization is impossible because of varying overhead requirements and difference of flame length of coal used.

Question:—Is there a standard height for a bridge wall? What are the functions of a bridge?

Answer:—There is no standard height for a bridge wall; the usual practice being 10 sq. inches per boiler horse power. The function of a bridge wall is to keep the fire on the restricted area of the grate, and the bridge wall when hot helps ignition and combustion by reflecting the heat forward to equalize with the cold air and fuel entering the furnace at the front.

Question:—Give sketch of a H. R. T. boiler giving approximate dimensions when using bituminous coal?

Answer:—Sketches made on the blackboard: Specifications diameter 72 inches, length 18 feet, set 48 inches above grate; grate 38½ square feet. The opening over the bridge wall was sufficient for the passage of the products of combustion (roughly one-sixth of the grate surface, plus the area of all the tube openings.) The combustion chamber slanted back down to the bottom of soot clean-out door.

Dimensions of main steam outlet, 6-inch feed pipe and valves, 2-inch blow down valve, 2-inch safety valves, two 2-inch pops. Manhole 11 x 15 inches. Tubes 4 inches by 18 feet.

Question:—Give a descripiton of three types of stationary grates, the reason why they are different and conditions where use is advisable.

Answer:—Straight, flat, narrow bars with narrow slots between; oval top, straight, cross-ribbed with narrow slots; flat cross ribbed (herring bone) with large slots; also grates with tapered and staggered holes. The straight, narrow bar is intended for saw dust or with either saw dust or tan bark. The flat, cross-ribbed or herring-bone with large sizes of bituminous coal. The sectional bars with tapered holes are used for hard coal screenings where forced draft is used. The herring bone is not so liable to be affected by warping as the other types of grates and gives little trouble when using the cleaning tools. Water-tube fire grates are used in connection with down draft boilers, and the circulation of water through them prevents them becoming warped or burned off by the fire in the under grate.

Question:—What fittings are standard on a boiler? What additional fittings are desirable and why?

Answer:—Water line gauges and try cocks. Steam pressure gauge and water syphon. Pop safety valve, fusible plug, main stop valve. Feed and connection with check valve, blow down valve, damper, lever and rod smoke connections including smoke box and larger doors, also various clean-out doors and fire doors.

Additional fittings: Surface blow off to skim organic substances from surface of water in boiler, soot blowers to blow off the soot from water tubes and the inside of fire tubes. CO2 recorder to indicate the relative combustion efficiency. Pressure and temperature recording instruments to further check up the efficiency. Also automatic damper regulator or, better still, automatic draft and damper regulator because higher efficiencies are obtainable than with hand regulation of either.

Question:—Why is it necessary to have a damper in each boiler? Describe desirable position for damper rod and method of graduation for damper opening?

Answer:—To regulate draft and thereby rate of combustion and evaporation. The desirable location of the damper rod (control lever) is at or near the front of the boiler and readily accessible. The damper rod may be graduated by marking intermediate points between the positions of full-shut and full open.

Question:—Give description of three types of boiler feed pumps and their individual advantages. Why is an injector not usually used except in emergency?

Answer:—Plunger, single acting duplex, rotary pumps. Rotary pumps may be either power or turbine driven, but have a much lower efficiency than the plunger type pumps. However they have advantages of handling very hot water and of lower cost and maintenance. While the duplex are more complicated than either the rotary or single acting pumps and require careful valve setting and more packing and adjusting, they create less shock to the boiler feed pipe, fittings and boiler, and when acting against high pressure the efficiency is much higher than either the single acting or rotary pumps.

An injector is seldom used except for emergency, because its efficiency compared with a regular feed pump or a H. P. steam trap is low; also it will not handle very hot returns or feed water, nor can it be used where there is considerable suction lift.

Question:—What is the function of a blow down valve? Cite some of the requirements of a blow down valve. Cite some of its weak points commonly met with.

Answer:—To lower the water level occasionally and thereby keep the sediment from the bottom of the boiler, and to empty the boiler when required.

Blow down valves should work freely and yet close tightly to prevent loss of hot water, and they should be made strong to sustain shock. There should be a combination of two valves always. Some valves fail to seat because of sediment lodged under the seat. Others tend to stick and are liable to be broken when forced open, and still others are leaky and corroded.

PULVERIZED FUEL BULLETIN

A new bulletin on the Quigley Fuel Systems, comprising methods of preparing, transporting, and burning of pulverized fuels has just been published by the Hardinge Company, 120 Broadway, New York.

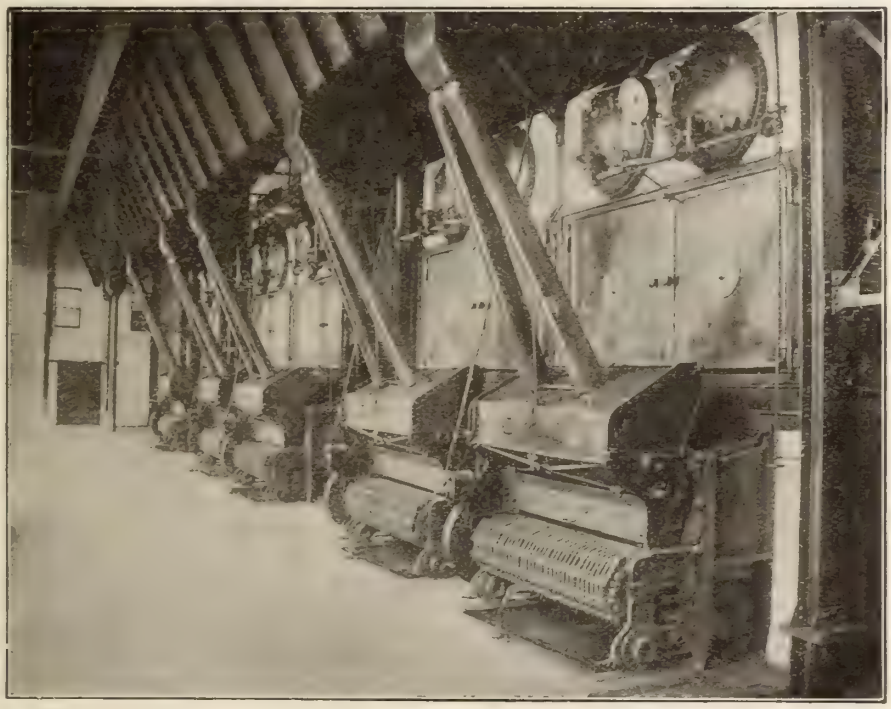
This bulletin is known as No. 12 and treats the subject of pulverized fuels in a manner never before attempted. One of its distinguished features is the fact that emphasis is laid upon the methods employed to properly prepare and burn the powdered coal, rather than occupying most of the space discussing the pulverizer.

This bulletin comes at a very opportune moment, for the burning of pulverized fuel has reached the stage in its development where its success is assured. It is now being specified by the largest power and heat engineers in the country as a solution to many problems involving the generation of heat.

Aside from complete plant layouts, what they term as a "Unit Milling Plant" is described. This layout is radically different from anything ever before developed. The system comprises a method of pulverizing and transporting the coal to one or more furnaces and continuous operation over extended periods.

This catalog will undoubtedly be very useful to the engineer designing power plants or furnaces requiring considerable quantities of heat, as facts and figures are given which will aid him in his work. At the same time, it is written in a way that will interest the non-technical person who is seeking a general knowledge of this most interesting and talked-of subject.

"B & W" STEAM BOILERS



Marine and Land Types

Installation of "B & W" Boilers and Mechanical Stokers at the Acadia Sugar Refinery, Dartmouth, N. S.

"LAGONDA" BOILER TUBE CLEANERS

Keep tubes free from scale. Driven by water, air or steam and designed for all tubes over two inches in diameter.

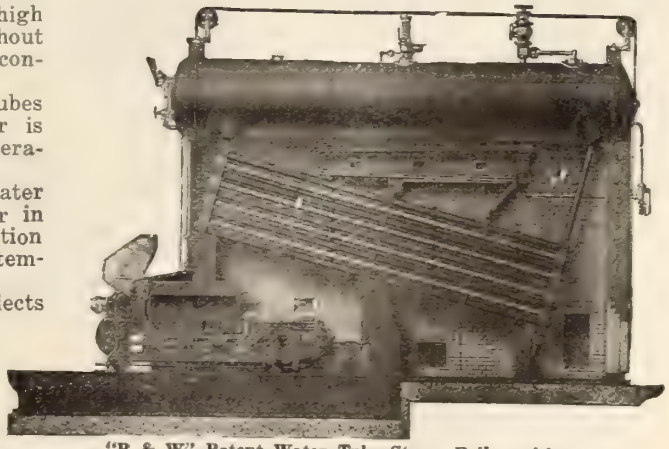
Entirely Devoid of Unequal Strains

All joints of B. & W. Boilers are removed from the immediate action of the fire. There are no unequal strains —no weak spots. You can gain high pressure with rapidity and without danger. Note these features of construction:

1.—A series of Inclined Water Tubes over furnace in which water is quickly raised to high temperature.
2.—A Horizontal Steam and Water Drum which keeps the water in rapid circulation in one direction and maintains a uniform temperature.
3.—A Mud Collector which collects all foreign matter.

B. & W. Stationary and Marine Water Tube Boilers are easy to clean, easy to erect and are as durable as boilers can be made.

Our catalog gives complete technical information. Shall we send it?



"B & W" Patent Water Tube Steam Boiler with Superheater and Mechanical Stoker

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OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

STEAM PER HOUR

Question:—Can you tell me the amount of coal that would be required to supply a drying room with steam under the following conditions? There is a live steam line of one inch diameter from the boiler room, and in the room there is a 6 inch pipe about 38 feet long. This pipe is reduced to ¼ inch at the end and the end is left open. The boiler horse power is 140.

Answer:—The boiler horse power does not affect the above question, but what would have more bearing would be the steam pressure. The amount of steam required per hour can very easily be determined with the lay out as given above, by simply catching the water of condensation and weighing it for one day, and then taking the average weight condensed p.h.. This would give the amount of steam used per hour, and the average evaporation per lb. of coal would give the coal required. If the steam is allowed to blow freely through the ¼ inch line there will be an unnecessary waste of steam. If we assume that the boiler steam pressure is 100 lbs. per square inch gauge, and that there is a drop from boiler to the end of the 6 inch pipe of 10 lbs. then we should have a pressure of about 90 lbs. per square inch at the ¼ inch pipe. We can then figure approximately the weight of steam escaping per hour from an opening of this size and at the pressure assumed. We can use Napier's formula, which is that the weight of steam that will escape through an orifice of one square inch in area is in 70 seconds just equal to its gross pressure. Then in one second it will be equal to 1-70th of this and in one minute 6-7ths. In formula form we have:

$$\text{Weight of steam per min.} = \frac{P\ A\ 6}{7}$$

where P is the gross pressure and A the area of opening.

Applying this to the problem in hand we have

Weight of steam per hour

$$= \frac{P\ A\ 6 \times 60}{7} = \frac{105 \times .049 \times 60}{7}$$

$$= 308.7 \text{ lbs.}$$

If each pound of coal as fired will evaporate 7 lbs. of water then the coal required will be

$$\frac{308.7}{7} = 44.1 \text{ lbs. per hour}$$

COMBUSTION BY OBSERVATION

Question:—I am firing a h.r.t. boiler, and am doing my best to get efficiency without the help of any instruments but a draft gauge, and what I can observe by the state of the fire and the results it gives. I have noticed that when the coal (Pocahontas) gives a long yellowish flame, the admittance of air over the fire causes the flame to shorten and become more nearly white. Is all combustion finished when the flame is ended as in the case of a short white flame and no smoke from a hot bed of coals? Can you tell me from this explanation how I should handle my fires to get the best results.

Answer:—The coal you are using is a semi-bituminous with a high carbon content and about 18 per cent. volatile matter in the combustible, and a heating value of about 15,000 B.T.U. This coal closely resembles Welsh steam coal in its analysis, and should be handled the same way to get the best results. What is required is to first distill the gases and ignite them by passing them over a hot fire, and afterwards to burn the remaining solid carbon. In order to do this on a hand fired grate a fairly thick fire should be maintained, and when fresh coal is put on it should be kept to the front of the grate, leaving a portion of the fire towards the bridge wall with no green coal at all. The coal will give off the gases or volatile matter and these will ignite and form a flame which will be yellow if not properly mixed with air, but which should be short and brilliant if the proper amount of air is being admitted. After the green coal has finished giving off this flame, it should be pushed back over the fire with a rake, taking care not to disturb the lower bed which will be composed of burnt coal and ash, and must not be mixed with the good coal on the top of the fire. A certain amount of smoke will be given off when the green coal is first put on but this is unavoidable and not to be greatly worried over. With this kind of coal the fire should be kept at least eight inches thick and twelve inches will give good results. Put a good charge on when you fire, and leave it as long as possible without disturbing it. Push the front back and slice occasionally but with care, and you will get good results. The writer has seen a boiler fired with Welsh coal where a fire was only put on once an hour.

Air should be admitted over the top of the fire while the distilling process is going on, but closed while the carbon is burning. The ventilators in the fire doors will give all that is needed as a rule.

Engineering News

The city council of Sydney, N.S., plan alterations and improvements to water works to cost $150,000.

The Dake Engine Co., Grand Haven, Mich., manufacturers of the Dake Engine, have opened a Canadian office at 45 Adelaide St. E., Toronto, Capt. Wm. Stitt is in charge of the new office.

The Ontario Creameries, London, Ontario are in the market for complete refrigeration and ice making equipment. About $30,000 of equipment will be purchased.

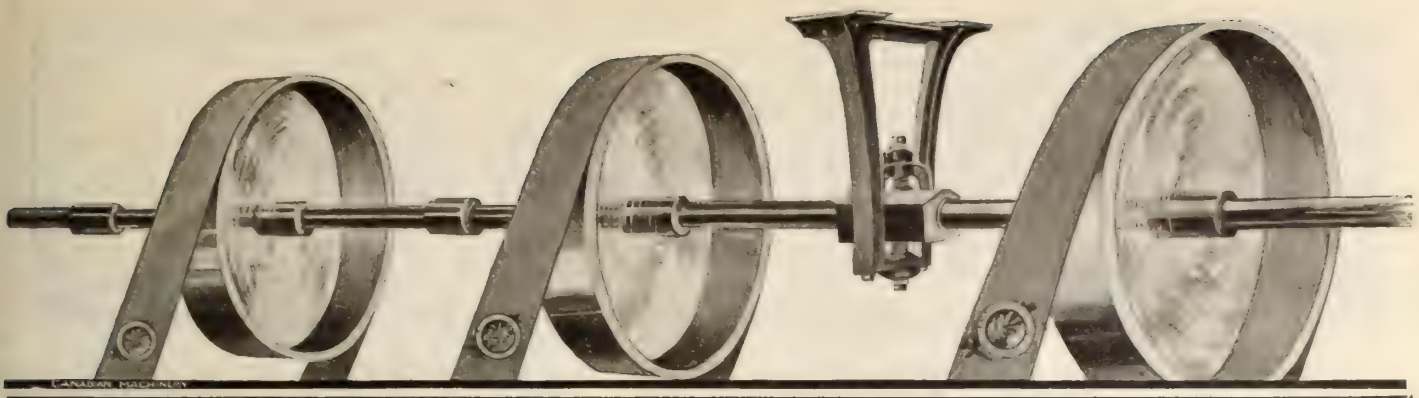
The city council of Merlin, Ont., plan electric lighting and power distribution to cost about $28,000. Similar plans are being made by the council of Walkerton, Ont., to cost about $40,000.

The city council of Wiarton, Ont., plan improvement to water works pumping, plant including the installation of an electric operative pump, and a large gasoline engine. Prices wanted on equipment. About $25,000 will be spent.

Charles Barber & Sons, manufacturers of turbines and power plant equipment, Meaford, Ont., have been sending their friends in the trade a very neat calendar for the New Year. The illustration is a reproduction of the famous picture of Canada's first parliament under Confederation and is most appropriate in that the Barber firm began business in this notable year, 1867.

In 1919 there was published by the Engineering Station of the University of Illinois a bulletin, No. 111, dealing with the forms in which sulphur occurs in coal. The research work in connection therewith was conducted in the Chemical Laboratory of the University of Illinois by S. W. Parr and A. R. Powell, who developed successful methods for determining quantitatively the different chemical forms of sulphur in coal.

By the end of January it is understood that the island plant (Fort William) of the Canada Starch Co., will again be operating at full capacity and employing a full staff of 220 employees. As is usual during the months of December and January, the plant is closed for general repairs and stock taking but it is stated that orders are plentiful and when the plant starts next month it will be operated without interruption.



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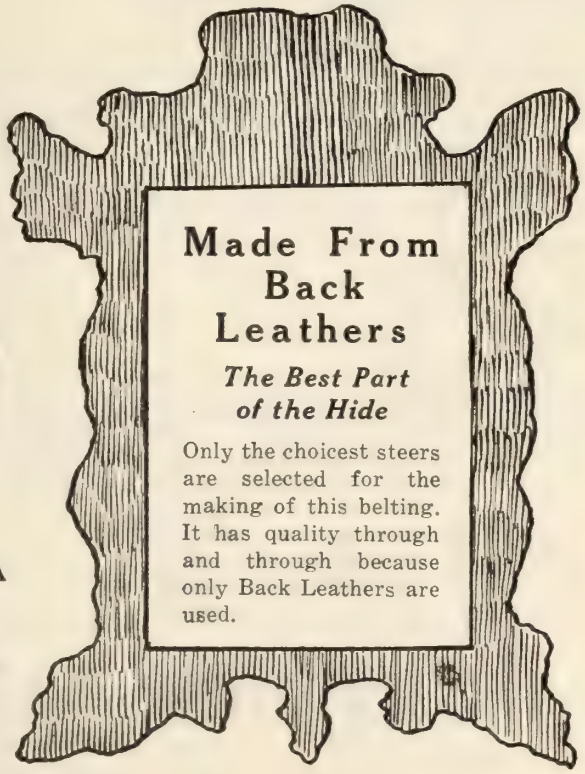
WHEREVER you see the Oak Leaf trade mark stamped on a leather belt in use you know the owner is getting really dependable and economical belt service. D. K. McLaren's Genuine British Oak Tanned Leather Belting gives this cheap service because it is made from the best leathers obtainable—tanned in the best way known. And Canadian users know it.

Every day, plants are giving D. K. McLaren's Leather Belting a trial and then adopting it exclusively; for in actual test they find all our verbal arguments true.

They find it so tough, pliable and stretchless that practically all power is put to use. If any is wasted it is inconsequential. Due to Oak Tanning this belting lasts long.

Oak Tanning

Every D. K. McLaren Belt is tanned by the celebrated English Oak Tanning process. It adds pliability to the original strength of the hide.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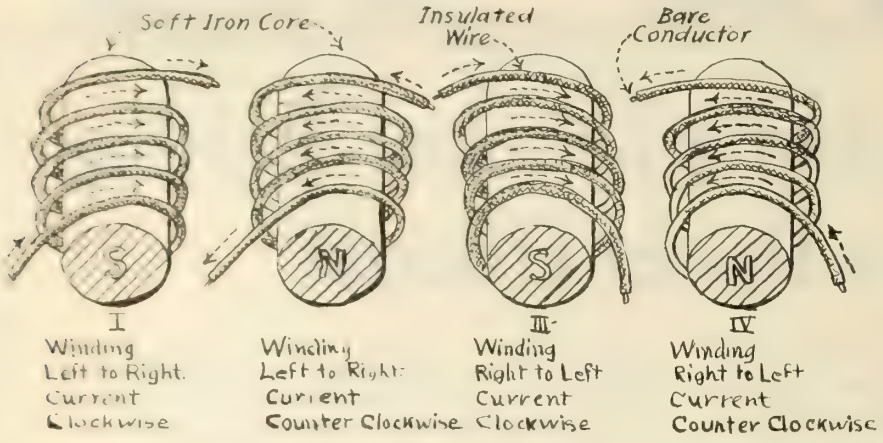

Showing magnetic polarities with different direction of winding and different direction of current.

DIRECTION OF WINDING DETERMINES THE POLARITY OF A MAGNET

(By C. O. Jackson)

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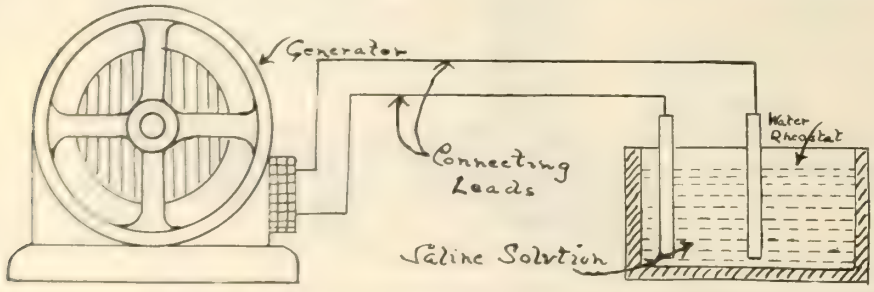
The effect of change of direction of current through the winding of an electro-magnet, or by change of direction of the winding is explained graphically by Fig. 1. It will be noted (see I, II, III, and IV) that there are four possible combinations. Thus the polarity is determined by two factors:—(A) the direction in which the coil is wound, that is, the direction in which the hand moves in winding it on, and (B) the direction in which the current is circulated through the coil. Application of the right-hand rule will verify the polarities specified in the illustration.

DRYING OUT GENERATORS

(By Robert Smith)

Probably the most effective method of drying out a generator, the windings of which have become damp in transit or from some other cause, is to short-circuit its armature on the line side of the ammeters and operate the machine with a very weak field, so adjusted that the temperature of the windings will not exceed possibly 65 deg. C. or 149 degrees F. Care should be exercised not to overheat the windings, because the temperature of the inner parts is likely to be considerably in excess of that of the exposed parts. Another method of drying out is to use a water rheostat for a load, as shown in Fig. 1, whereby the armature current may be adjusted.



Arrangement of water rheostat for drying out generator.

ELEVEN OHMS AS THE RESISTANCE OF A CIRCULAR MIL FOOT OF COPPER WIRE

(By L. R. Grant)

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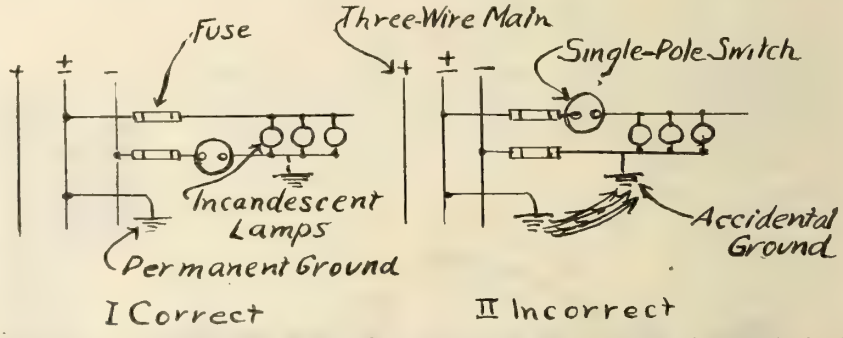
The resistance of a cir.-mil ft. of copper is determined by the purity of the copper and on its temperature. The resistance of ordinary commercial soft-drawn copper wire at 70 deg. Fahr. is almost exactly 10.6 ohms. However, the use of the value of 11 ohms in most formulas is justified. In computing wire sizes for interior wiring circuits, it is folly to endeavor to figure too closely. The length of the circuit is probably not known within ten per cent., the purity of the copper to be used unknown, and finally, one must use conductors of one of the standard wire gage sizes. Hence it is common practice to use the 11-ohms value, given above, in practical calculations. The result obtained by using it will, on the average, be as accurate as those obtained by using 10..6 ohms, and it is an easier figure to handle. Also the value "11 ohms" can be memorized readily.



Correct and incorrect methods of installing single pole switches in two wire branch circuits feeding from three wire mains.

SINGLE-POLE SWITCHES FOR THREE-WIRE BRANCHES

(By J. W. Carter)

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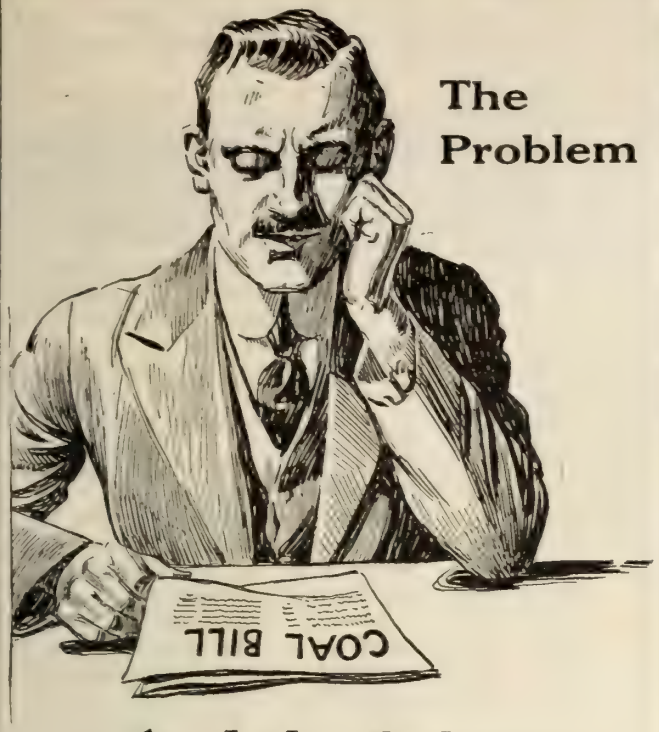
When a single-pole switch is cut in a branch-circuit wire which connects to the neutral, a short circuit current, as shown at Fig. 1, I, may flow (regardless of whether the switch is "open" or "closed") if there is a ground on the side wire of the branch circuit. The neutral wire of a three-wire system is, as illustrated, always grounded. Where the switch is cut in the wire, which does connect to the neutral (Fig. 1-I), such a short circuit current cannot flow when the switch is open.



The Problem

--And the Solution

Leaks in the boiler room that lead up to top-heavy coal bills are a problem demanding quick action from every plant executive. The permanent solution is BAILEY **Boiler Meters.** On easily-read charts they point out poor conditions and enable the fireman to quickly find a remedy.

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EFFECT OF OVER AND UNDER-VOLTAGE ON A THREE PHASE MOTOR

By W. A. Brown

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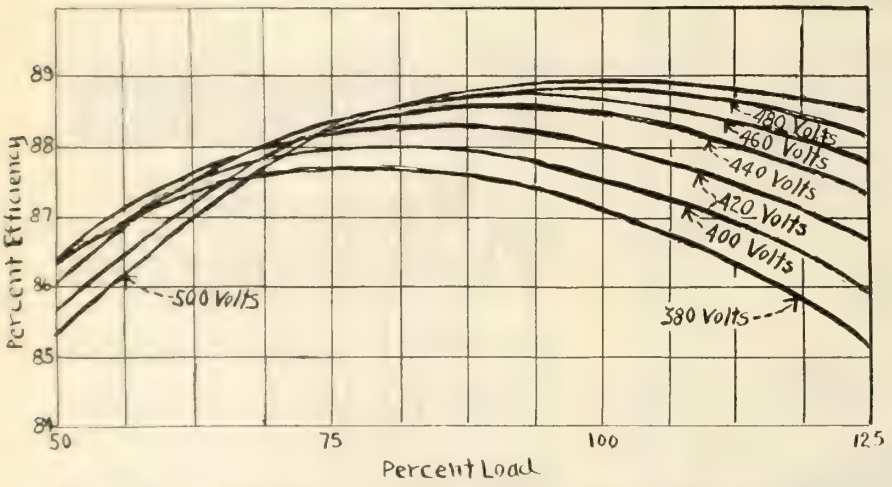
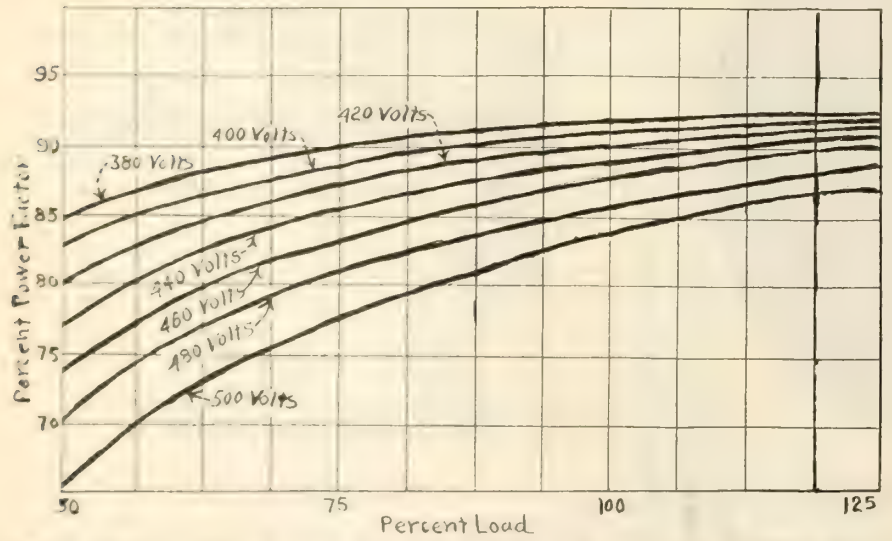
The accompanying graphs, Figs. 1 and 2, and the following table give typical performances (Westinghouse Electric & Manufacturing Company's data) which result when a 440-volt 3-phase-60-cycle induction motor is operated on voltage above or below 440. It will be noted that the power factor decreases as the impressed voltage is increased. The efficiency decreases as the voltage is increased at partial loads but above about three-quarters load the efficiency increases with the voltage.

	Per cent, Efficiency Per cent. Full Load				Per cent. Power-Factor Per cent. Full Load			
Volts	50	75	100	125	50	75	100	125
380	86.35	87.7	87.05	85.1	84.8	90.2	92.2	93
400	86.3	87.92	87.5	85.85	82.8	88.8	91.4	92.5
420	86.35	88.18	88	86.7	80	87.5	90.4	92
440	86.3	88.22	88.46	87.3	77	85.5	89.2	91.2
460	86	88.3	88.6	87.8	73.8	83.3	88	90.4
480	85.68	88.22	88.8	88.15	70.2	80.8	85.8	88.7
500	85.3	88.2	88.87	88.5	65.4	77.0	83.7	87.2



Graphs showing relation power factor and load of a 440-volt, 3-phase induction motor operated on different voltages.



Graphs showing relation of power factor and load of a 440-volt, 3-phase induction motor operated on different voltages.

LIGHTNING'S BETTER FEATURES

We hear innumerable stories about the depredations of lightning and have learned to look only on its bad characteristics such as striking telegraph wires and killing line men fifty miles away or following the power line down into a coal mine and setting off the dynamite chamber, but we seldom think of it as a benefit to mankind, but it has been known to have remarkable restorative properties in cases of incurable disease. In Connecticut a woman who was as deaf as a lamp post had her power of hearing restored in a marvelous way. To penetrate to where this woman was in her house the bolt had to shatter several rafters, pass through two floors and demolish windows and frames before reaching her body. She became unconscious and was badly shaken up, but upon regaining her senses was well able to hear.

A case somewhat opposed to this but equally as remarkable was that of a man who had been afflicted with paralysis from infancy and who was struck by lightning and rendered unconscious for a short time, but after recovering from the shock he gradually regained the use of his limbs but was permanently deaf.

A woman who had been paralyzed for thirty-eight years was struck by lightning and cured.

Another woman who had paralysis of the vocal cords which rendered her speechless was struck by lightning and whether it was the lightning or the fright, she screamed and has since had the use of her tongue.

Many miraculous cases are recorded of people having their shoes and clothing torn off by lightning while receiving no bodily harm.

Another point worthy of note is that there is no record of anyone ever being struck by lightning while sitting in an automobile. This is probably due to the fact that rubber tires act as non-conductors, and unless the car is submerged in water, or the tires are deflated so that the rims form a contact with the ground, there is not the slightest chance of a car being struck by lightning.

BULLETINS

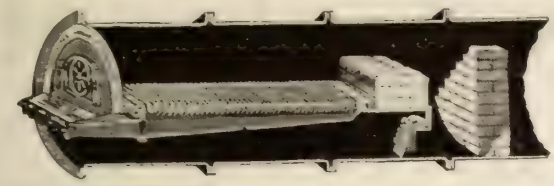
The American Steam Gauge and Valve Manufacturing Co. have issued a bulletin describing their American Recording Thermometers. These instruments are made for a variety of temperature conditions, up to 1000 degrees Fahrenheit. The bulletin which is in folder form fully describes this new line.

The National Meter Co., New York, have issued a bulletin describing their Empire Oil Meters for fuel and other oil measurement. The bulletin shows illustrations of all the parts of the meters, which are numbered, and a corresponding numbered list.

At the Southern Experiment Station of the Bureau of Mines, Birmingham-Tuscaloosa, Ala., determinations have been made as to the relative combustibility of different cokes in a brick combustibility furnace. Further work was done with the shatter and friability tests, and the true and apparent gravity determinations are practically complete. Float and sink tests have been made on a sample of coke breeze submitted by the Sloss Sheffield Company to determine if sufficient ash elimination could be obtained to make feasible the mixing of cleaned coal with raw coal before carbonization.

The sampling of coals from the mines of Carbon County, Utah, has been completed by the Bureau of Mines. A bulletin on the analysis of Utah coals generally is being prepared for publication.

The TURBINE Furnace



First Set Accepted and Another Ordered

Result of Tests of P. Burns & Co., Vancouver

A No. 3 Boiler with "Coalmont" Run of Mine on Shaker Grates before TURBINE FURNACE was installed. With "Coalmont" Slack after installation. Return Tube Boiler, 144 H.P. H.S. 1440 Sq. Ft. 12 tests taken.

	Before	After
Equiv. Evap. per hour	4363.5	5261
Boiler H.P. developed	129.3	171
Evap. per Lb. of fuel from & at 212° F.	6.82	7.82

RESULT—Notice that for equal outputs less Slack is used than Run of Mine previously. Thus the saving is Greater than the difference of the two fuels.

If you burn high grade coal in your heating plant, why not install a set of TURBINE FURNACES and burn slack, sawdust, etc. Enquiries solicited.

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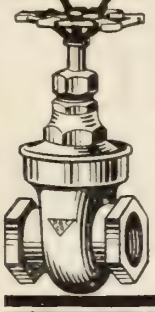

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—To protect the competent engineer and his vocation.
—To enroll all competent engineers in this organization.
—To impart information beneficial to the profession.
—To assist members out of employment to obtain the same.
—To procure by legal enactment greater safety in the operation of steam plants.
—The belief that knowledge and ability of one's profession is what is necessary to make success possible.

Brother Engineer:

Did it ever appeal to you to join an association devoted entirely to the interests of the engineering profession; one which by means of lectures, illustrated and otherwise, delivered in the lodge room, tends to keep its members right up to the minute with the progress made in the engineering professions?

If you are interested in an association of this kind, and live where less than fifteen engineers reside, send for a copy of our constitution, and make application to the nearest lodge for membership. If you live where more than fifteen engineers live, get together and send in a written application to me.

The undersigned will be very pleased to give any further information required.

F. HARPER, President Grand Lodge.
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Was the New Cabinet Made in Montreal?

THE SECRET of the Cabinet is out. J. K. Munro, whose observations on what goes on behind the scenes in Ottawa have amused, entertained and instructed readers of MACLEAN'S in recent years, "explains" what happened when Premier Mackenzie King endeavored to pick his own Cabinet members.

Of course you will want to read this "inside" story of Canadian politics in

MacLean's Magazine
for
February 1st

which is on sale at all news-stands to-day.
This issue also includes several timely and authentic articles on subjects of national importance to Canadians, as well as a particularly attractive list of entertaining fiction, and a generous measure of Reviews.

Here's the "Inside Story"

According to Mr. Munro:

"Crerar had read the King proposals to his Western Progressives assembled at Saskatoon, and had so far received their approval that he was on his way East, presumably to close the deal.

"Then something happened. Sir Lomer Gouin and Senator Dandurand are represented as visiting Ottawa and turning the Liberal leader's plans topsy-turvy." Mr. Munro goes on to say: "The Cabinet slate had been smashed. . . . . A different reception had been prepared for the Hired Man's Hero. . . . . What did the little Quebec Boss do in those three hours? Well, report says that he went straight to the Rideau Club, where the young Premier-to-be was waiting for him in the 'Silence Room' (that said silence was so rudely shattered that a frightened waiter crept up and closed the door); and that behind that closed door an embryo statesman had it made plainly evident that the powers that made could unmake; and that a Quebec that had given him a sullen support would rise and rend him unless he listened to her voice—and Sir Lomer had Quebec's voice about his person."

READ THESE FOR INFORMATION:

THE WEST WON'T STAY DOWN —by Charles Christopher Jenkins: The second of two up-to-the-minute articles showing how the Canadian West is meeting its [illegible] agricultural, financial, economic, commercial and social problems in these days of stress and strain.

FAR NORTH REALLY LIVABLE —by Vilhjalmur Stefansson: Canada's foremost Arctic explorer gives facts and figures to prove that life in the Land of Winking Night can really be pleasurable and profitable.

THAT MAN FROM CARSTAIRS— by Nicholas North: A breezy, informative sketch of Henry Wise Wood—formerly "That Man from Missouri"—who wields such a potent influence in Albertan politics.

SLEUTHS OF THE WILDERNESS —R. G. MacBeth: A series of fascinating — and true — tales of Canada's famous red-coated force, and how offenders are tracked for months and years, by the Dominion's relentless, tireless preservers of peace in the wilds.

AND THESE FOR ENTERTAINMENT:

A PRIMROSE AND A PROMISE —by Margaret Busbee Shipp: A light little love-story which commences on a continental train, progresses through the tulip hills of Holland, and culminates in an international hockey match.

THE SAIL-DRAGGER—by Frederick William Wallace: A melodrama of the sea; which includes a pretty typist, a brawny hero, half a dozen Bolsheviks and a mysterious will,—all the ingredients of a fascinating "thriller."

HOW "BOB'S MAGGIE" GREW INTO HER JOB—by Ethel M. Chapman: The fascinating and adventurous life-story of Dr. Margaret Patterson, Toronto's new Police Magistrate.

ON THE JOB — by Archie McKishnie: "The Swallow" decided to go straight, but found many influences endeavoring to force him once again into the influences of the underworld. Mr. McKishnie, as usual, has a strong "twist in the tail" in this yarn.

MOSTLY SALLY—by Pelham Grenville Wodehouse: Some more about Sally and her fortune, and Ginger and his foibles.

THE HOUSE OF APPLEDORE—by "Sapper"—H. C. McNeile: "The Writer's Story": how a journalist was imprisoned, how he faced death, and how he used a clever code to escape.

ODETTE ELOPES—by Margaret Hilda Wise: A simple little tale, entertainingly told, of a girl who announced her elopement.

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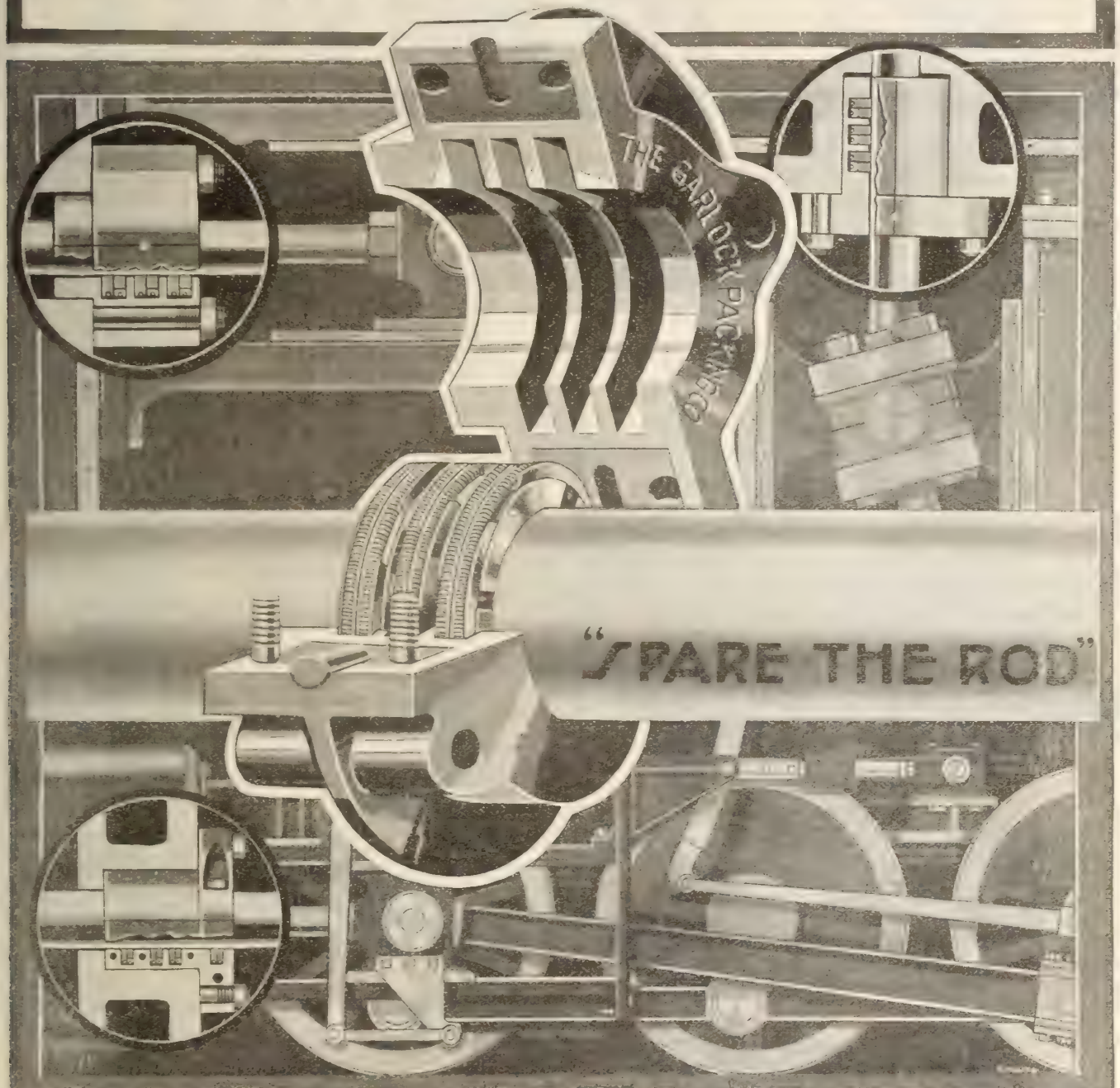

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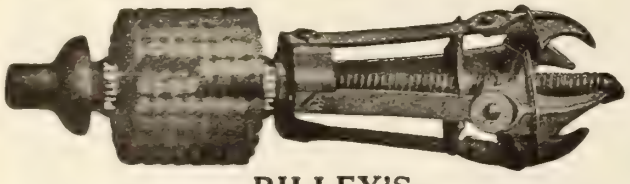

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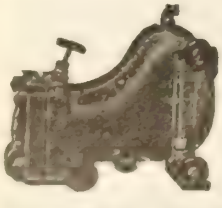

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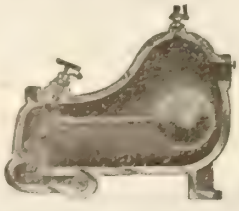

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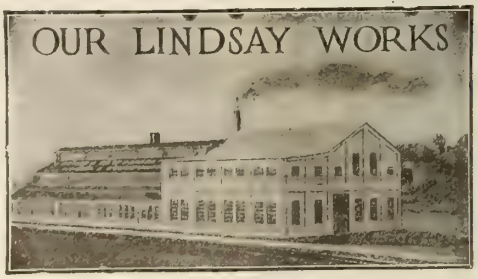

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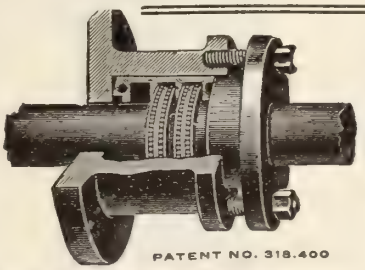

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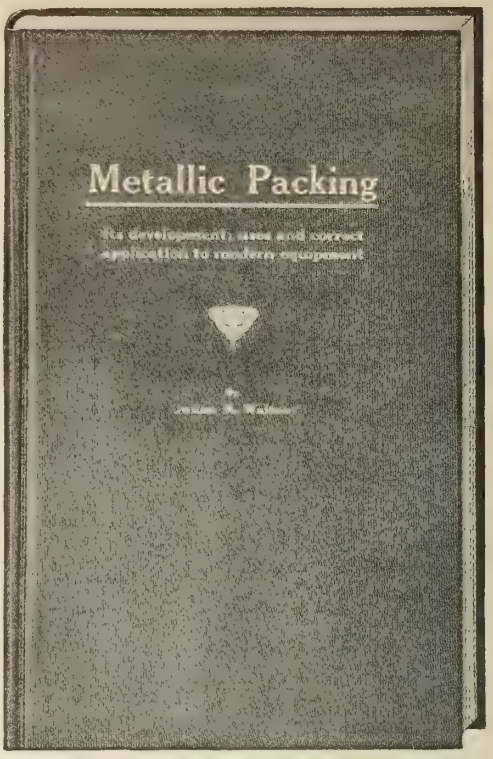

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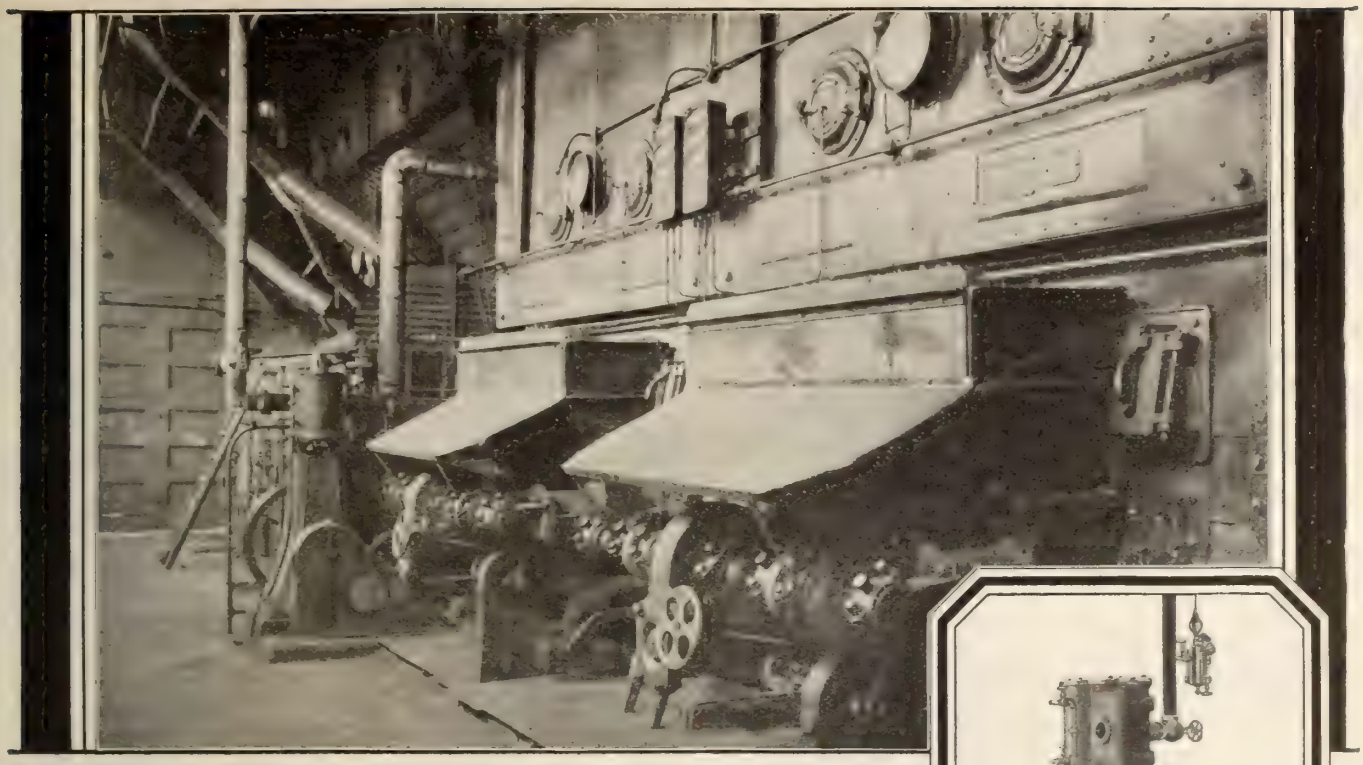

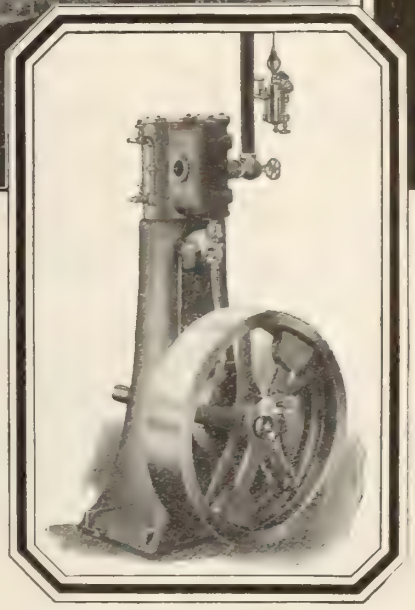

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Gutta Percha & Rubber Co., Limited.

BELTING, RUBBER
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Limited, Toronto.
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTIN , STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, STITCHED COTTON
D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, SOLID WOVEN
D. K. MacLaren, Ltd., Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BIBS, COMPRESSION
Mueller Mfg. Co., Ltd., The.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINES
Canadian Sirocco Co., Ltd., Windsor, Ont.
Kingsbury Machine Works, Frankford, Philadelphia, Pa.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

BOILERS
Gelinas & Pennock, Reg'd, Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal
C. B. Turner, Toronto.

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
C. B. Turner, Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
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Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

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Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto

BOILER PRESERVATIVES
Johns-Pratt Co., The, Hartford, Conn.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd, Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER LINING, PLASTIC
C. B. Turner, Toronto.

BOILER SETTING CEMENT
Jointless Fire Brick Co., Chicago, Ill.
Beteon Plastic Fire Brick Co., Inc., Rome,

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.
C. B. Turner, Toronto.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

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Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

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Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
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Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
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York Manufacturing Co., York, Pa.

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Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

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Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Bowlus Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

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Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

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Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
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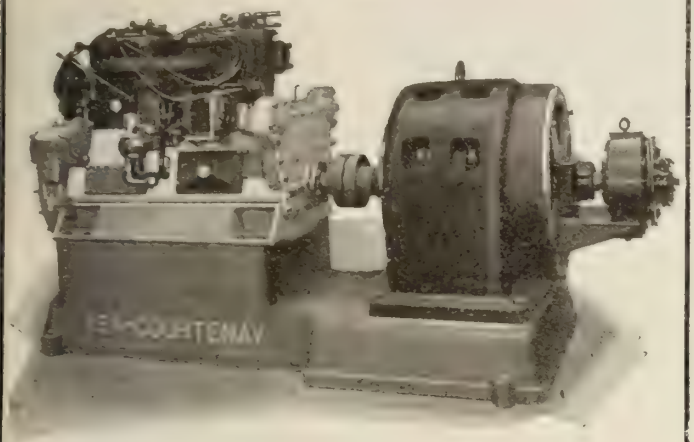

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Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
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Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
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Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis
Waterous Engine Works Co. Brantford.

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Can. Mead-Morrison Co., Ltd., Montreal
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MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
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Waterous Engine Works Co., Brantford.

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MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal

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Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford
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Garlock Packing Co., Hamilton, Ont.

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Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

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Smart-Turner Machine Co., Ltd., Hamilton.

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Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

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Canadian Link-Belt Co., Toronto.
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CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
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CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
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York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

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Canadian Sirocco Co., Ltd., Windsor, Ont

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Bowser Co., Ltd., S. F., Toronto, Ont

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MacGovern & Co., Inc., Montreal, Que.

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MacKinnon Steel Co., Sherbrooke, Que.

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Babcock & Wilcox, Ltd., Montreal.

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Penberthy Injector Co., Windsor, Ont.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, Que.
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Lincoln Electric Co. of Can., Ltd. Toronto

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co. Ltd., Toronto.
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ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
B. F. Sturtevant Co., Boston Mass.

ELECTRICAL MATERIALS
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MacKinnon Steel Co., Ltd., Sherbrooke.

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Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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MacKinnon Steel Co., Sherbrooke, Que.

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Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

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H. Mueller Mfg. Co., Sarnia, Ont.

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Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
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Goldie & McCulloch Co., Galt.
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Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

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Leonard & Sons, Ltd., E., London, Ont

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford

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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.

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Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Sturtevant Co., B. F., Toronto, Can.

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Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia

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Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

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Jas Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

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Beveridge Supply Co., Montreal.

EYE BOLTS
Williams & Co., J. H., Brooklyn, N.Y.

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Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Sturtevant Co., B. F., Toronto, Can.

FAN ENGINE REGULATORS
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

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Bailey Meters Co.

FEED WATER PURIFIERS
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Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
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Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

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S. F. Bowser Co., Ltd., Toronto, Ont.
Laurie & Lamb, Montreal.
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FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

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W. R. Sexton Co., Toronto.
C. B. Turner, Toronto.

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Beveridge Supply Co., Montreal.
Betson Plastic Fire Brick Co., Inc., Rome, N.Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.
C. B. Turner, Toronto.

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Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

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Jamison Cold Storage Door Co., Hagerstown, Md.

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H. Mueller Mfg. Co., Sarnia, Ont.

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FITTINGS
Crane's Limited Montreal.

FITTINGS, CAST IRON
Crane's Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Ltd., Montreal

FITTINGS, MARINE
Jas. Morrison Brass Mfg. Co., Toronto.

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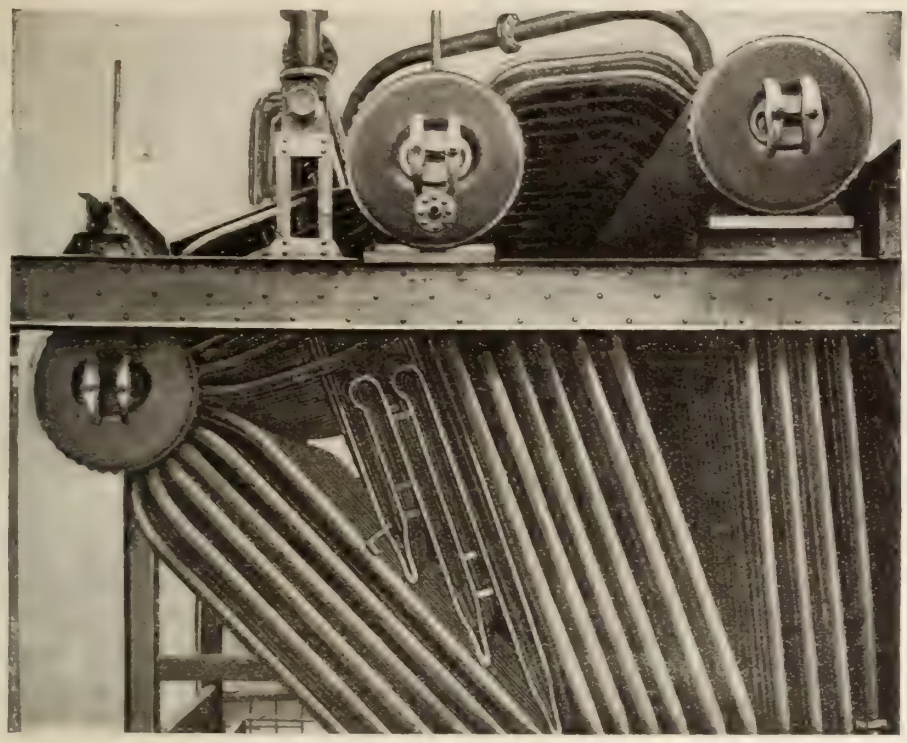
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont



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S. F. Bowser Co., Ltd., Toronto, Ont.

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International Chemical Co., Toronto, Ont.
Johnston Fire Brick Co., Chicago, Ill.

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Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
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International Chemical Co., Toronto, Ont.
Johnston Fire Brick Co., Chicago, Ill.

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Canadian Johns-Manville Co. Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Northern Electric Co., Ltd., Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
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Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.

GAS METERS
Bailey Meter Co.

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Frick Co. Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.

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Sarco Co., Inc., New York, N.Y.

GAS ANALYZERS CO-2
Dominion Flow Meter Co., Toronto.

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S. F. Bowser Co., Ltd., Toronto, Ont.

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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Penberthy Injector Co., Windsor Ont.

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American Steam Gauge & Valve Mfg. Co. Boston, Mass.

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Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.
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Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
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Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

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Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

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Goldie & McCulloch Co., Galt.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

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Arthur S. Leitch Co., Ltd., Toronto.

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MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

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Waterous Engine Works Co., Brantford.
Mason Regulator & Eng. Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

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Can. Mead-Morrison Co., Ltd., Montreal.

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Gelinas & Pennock, Reg'd, Montreal.
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Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd. Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. B. Sexton Boiler Setting Co., Toronto.

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Canadian Steam Boiler & Equipment Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. B Sexton Co., Toronto.

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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

GREASES
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Can. Fairbanks-Morse Co., Ltd., Montreal
W. B. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
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Northern Crane Works, Walkerville, Ont.

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Goodyear Tire & Rubber Co., Toronto.

HOSE, RUBBER
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Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.

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HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
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Frick Co., Waynesboro, Franklin Co., Pa.
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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.

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INSULATORS
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IRON FILLER
Canadian Johns-Manville Co. Ltd., Toronto.

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S. F. Bowser Co., Ltd., Toronto, Ont.

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Smart-Turner Machine Co., Ltd., Hamilton

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Arthur S. Leitch Co., Ltd., Toronto.
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Maclean Underfeed Stoker Co., Toronto,
Sanford Riley Stoker Co., Worcester, Mass.
Maclean Underfeed Stoker Co., Toronto, Toronto, Ont.

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Montreal.
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Shell Bar Boico Supply, Ltd., Toronto.

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Flexible Metallic Packing Co., Windsor, Ont.
S. F. Bowser Co., Ltd., Toronto, Ont.

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Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

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Goldie & McCulloch Co., Galt.
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MacGregor & Co., New York.
Waterous Engine Works Co., Brantford.

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PRESSURE AND VACUUM RELIEF VALVES
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PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS
D. K. McLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullough Co., Galt.
Waterous Engine Works Co, Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

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Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, BILGE.
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co Brantford.

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Smart Turner Co., Hamilton, Ont.
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Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Pratt & Cady Hartford, Conn.

PUMPS, GAS
Smart, Turner Co., Hamilton, Ont.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
Darling Bros., Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio
S'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart Turner Machine Co., Hamilton
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co (Inc.), Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Wallaceville
The John H. McGowan & Co., Cincinnati, Ohio
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co, Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek.
Darling Bros Ltd., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's Limited, Montreal.

RADIATOR TRAPS
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boico Supply, Ltd., Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Canadian Johns-Manville Co. Ltd., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnal-Waring Co. Philadelphia, Pa.

RECORDEDS CO2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATOR PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Toronto, Ont.

REGULATING VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

RODS, COPPER, BRASS AND BRONZE
H. Mueller Mfg. Co., Ltd., Sarnia.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID, RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto Toronto.

EXPANSION ENGINES SINGLE, COMPOUND AND TRIPLE
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd., Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.

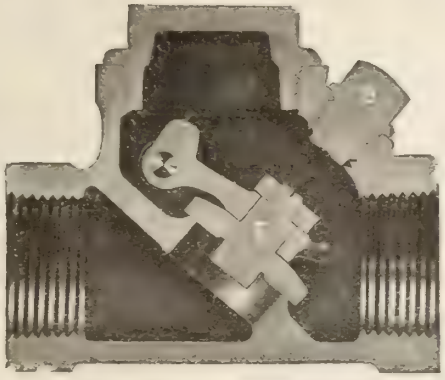
SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.

TRADE PENBERTHY MARK.

BE SURE THIS NAME IS ON THE VALVE YOU BUY



Cut No. 544-A

SWING CHECK VALVE

Get Away From Check Valve Troubles

by installing

The Penberthy Double Plug Check Valve

on Your Steam Lines

Cut No. 544A shows sectional side view and illustrates to advantage the liberal thickness of metal in diaphragm. (See letter D), also the even distribution of metal throughout. The disc (letter E) is also of liberal thickness, and as same is made of a special wear resistant bronze composition the Penberthy Check is practically indestructible, and will give many years of efficient service. All genuine Penberthy Checks bear our trade mark and the registered pressure 200 lbs., is also cast on each.

The double plug construction makes it possible to take the valve apart if mounted on a wall pipe without disconnecting same from the pipe. The plugs also act as bearings for the disc carrier pin and in case of wear it is only necessary to renew either plugs or pin, making valve as good as new. The top plug "B" is also removable for insertion of screw driver when regrinding disc and seat is necessary.

Stocked by leading jobbers everywhere.

Manufactured by

PENBERTHY INJECTOR CO., LIMITED
WINDSOR CANADA

Goldie & McCulloch Co., Galt.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM JETS
Green Engineering Co., East Chicago, Ind.

STEAM SPECIALTIES
V. D. Anderson, Cleveland, Ohio.
Can. Fairbanks-Morse Co., Montreal
Can. Farnsworth Co., Toronto
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
[illegible] Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

STEAM METERS
Bailey Meter Co.

STEAM CALORIMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

STEAM TRAP TOOLS
Crane's Limited, Montreal.
H. F. Sturtevant Co., Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
[illegible] Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
[illegible] Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Gehnas & Pennock, Reg'd, Montreal.
Green Engineering Co., East Chicago, Ind.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
[illegible]mpay Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.
Underfeed Stoker Co of Canada, Ltd. Toronto, Ont.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STATIONARY
The Superheater Co., Ltd., Montreal.

SUPERHEATER, LOCOMOTIVE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM SHOVEL
The Superheater Co., Ltd., Montreal.

SWITCH AND SWITCH BOXES
Canadian Johns-Manville Co. Ltd., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Johns-Manville Co. Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Mason Reg. & Eng Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
H. F. Bowser Co., Ltd., Toronto
[illegible] Oil Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay
H. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
H. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Sherbrooke.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, WELDED
Lincoln Electric Co. of Can., Ltd., Toronto

TAPPING MACHINES
Mueller Mfg. Co., H., Sarnia, Ont.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS INDICATING AND RECORDING.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Toronto, Canada.
[illegible]ailing Instrument Co., New York, N.Y.

THERMOSTATS
Sarco Co., Inc., New York, N.Y.

TOOLS
Mueller Mfg. Co., H., Sarnia, Ont.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y

TOBACCO PRESSES, HYDRAULIC
The John H. McGowan & Co., Cincinnati, Ohio.

TRANSFORMERS
Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville

TRANSMISSION TOWERS
MacKinnon Steel Co., Sherbrooke, Que.

STEAM TRAPS
American District Steam Co., North Tonawanda.
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
J. T. Long, 84 Adam St, Montreal, Que
Mason Regulator & Eng. Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.
Taylor Instrument Co., Toronto, Ont.

SWITCH BOARDS
Northern Electric Co., Ltd., Montreal

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co, Julian, Boston, Mass.

TACHOSCOPES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

TRAPS
Canadian Sirocco Co., Ltd., Windsor, Ont.

TRAPS, VACUUM
Darling Brothers, Ltd., Montreal, Que.

TACHOMETERS, INDICATING AND RECORDING
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

TRUCKS, FACTORY
Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co., Ltd., Ottawa.

TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Pilley Packing and Flue Brush Mfg. Co. St. Louis Mo

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal

TUBES, BOILER
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.

TURBINE PATENT FURNACE
P. A. Goepel, Vancouver, B. C., Canadian Agent.

TURBINES, POWER
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
H. F. Sturtevant Co., Boston, Mass.

TUBES, COPPER AND BRASS
H. Mueller Mfg. Co., Ltd., Sarnia.

TUNGSTEN LAMP (VACUUM AND GAS-FILLED TYPES)
Penberthy Injector Co., Windsor, Ont.

TURBINE WATER WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Escher Wyss & Co., Montreal.
Hamilton Co., Wm., Peterboro, Ont
MacKinnon & Co., Inc., Montreal, Que

TURBINES, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
Escher, Wyss & Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
B. F. Sturtevant Co., Boston, Mass.

UNIONS
Can. Fairbanks-Morse Co., Montreal.
Crane Ltd., Montreal
Dart Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

UNIONS, BALL JOINT, COMBINATION, FLANGED PIPE, GROUND JOINT, MALLEABLE IRON, FLANGE, PIPE, SWING
Dart Union Company, Ltd., Toronto, Ont

VALVES
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
[illegible]ck Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

VALVES, ACID RESISTING
Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa.

VALVES, AIR
Lunkenheimer Co., Cincinnati, Ohio.
H. Mueller Mfg. Co., Ltd., Sarnia.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE
Fisher Governor Co., Inc., Marshalltown, Iowa.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, HYDRAULIC
Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS
Crane Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Ltd., Sarnia.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, CONDENSER, PUMP, RUBBER
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal

VALVES, FOOT
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Kerr Engine Co., Walkerville, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, GATE
Babcock & Wilcox, Ltd., Montreal.
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.
Shell Bar Boico Supply, Ltd., Toronto.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.

VALVES (IRON), STANDARD EXTRA HEAVY
Crane's Limited, Montreal.
Dominion Steel Products Co., Ltd., Brantford, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady Co., Hartford, Conn.

VALVES, NON-RETURN STOP
Can. Fairbanks-Morse Co., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady Co., Hartford, Conn.

VALVES, POP
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.

VALVES, PUMP
Can. Johns-Manville Co., Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Mach. Co., Ltd., Hamilton.

VALVES, RADIATOR
Dominion Steel Products Co., Ltd., Brantford, Ont.
Jenkins Bros., Ltd., Montreal.
Watson & McDaniel Co., Philadelphia.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Shell Bar Boico Supply, Ltd., Toronto.
York Manufacturing Co., Philadelphia.
Jas. Morrison Brass Mfg. Co., Toronto
Mason Regulator & Eng. Co., Montreal.
Sarco Company, Inc., New York.

VALVES, REDUCING
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
Mason Reg. & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
Darling Brothers, Ltd., Montreal, Que.
Dominion Steel Products Co., Ltd., Brantford, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

VALVES, RELIEF
H. Mueller Mfg. Co., Ltd., Sarnia.
Arthur S. Leitch Co., Ltd., Toronto.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Pratt & Cady, Hartford, Conn.

VALVES, REGULATING
H. Mueller Mfg. Co., Ltd., Sarnia.
Pratt & Cady, Hartford, Conn.

VALVES, SAFETY THROTTLE
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
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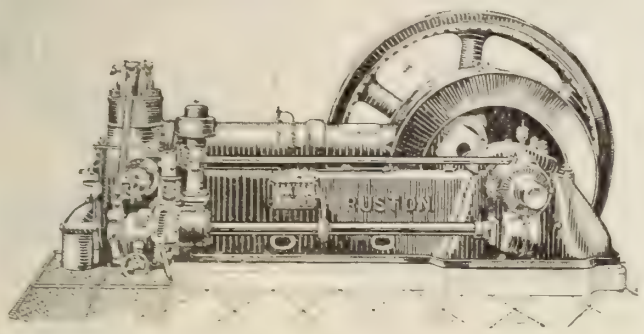

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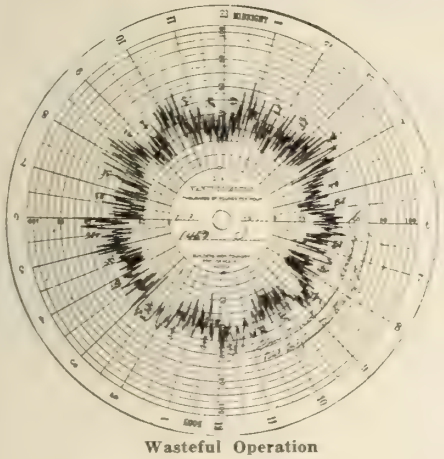

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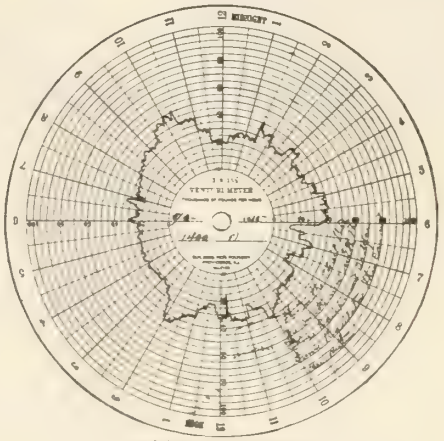

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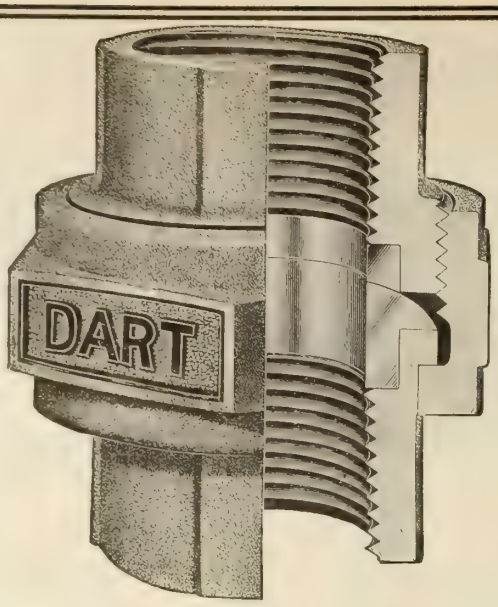

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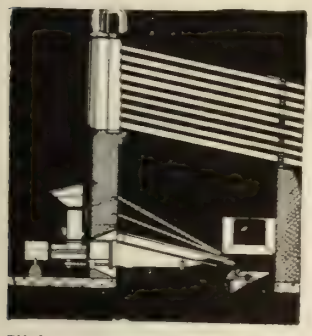

Slight slope of Jones "A-C" retort compared with gravity feed retorts (indicated by dotted lines). Instead of gravity fuel movement, positive movement.

Simplicity— without a single sacrifice

Jones "A-C" high side tuyeres (above) compared with ordinary type (below). Increase furnace width; keep fire and clinker away from side wall.

The simple balanced dump plate easily operated by one man.

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Fig. 106

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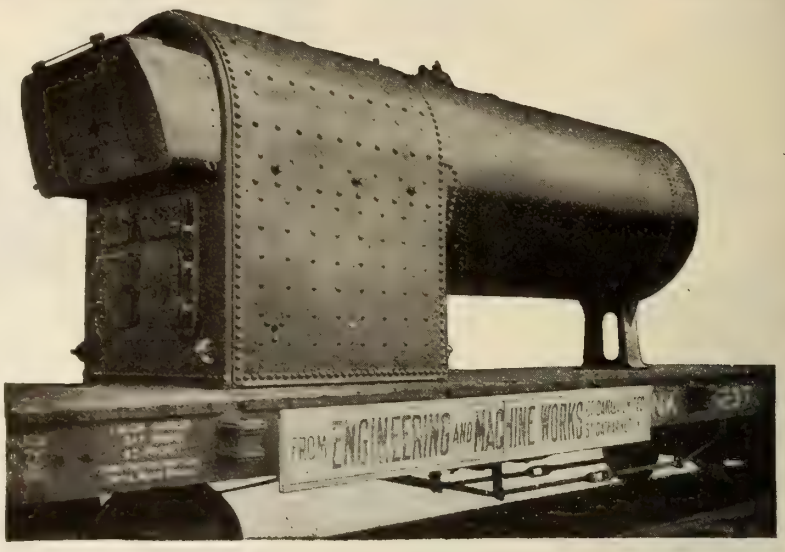

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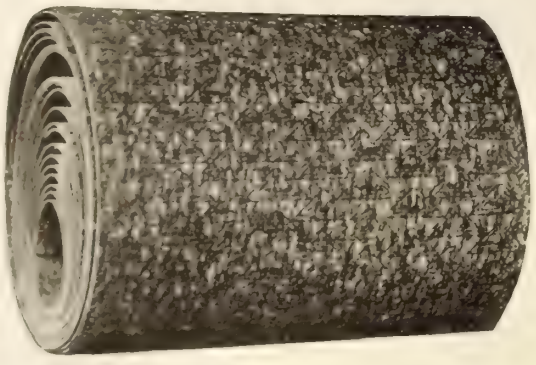

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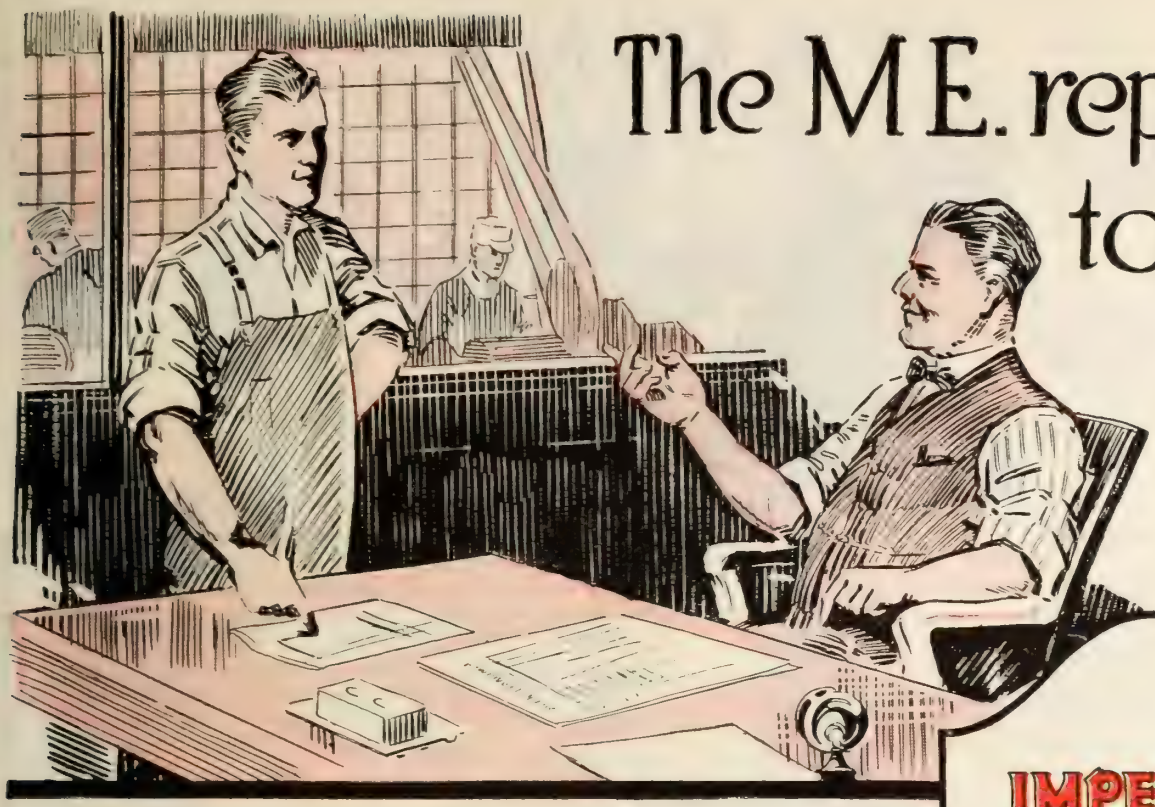

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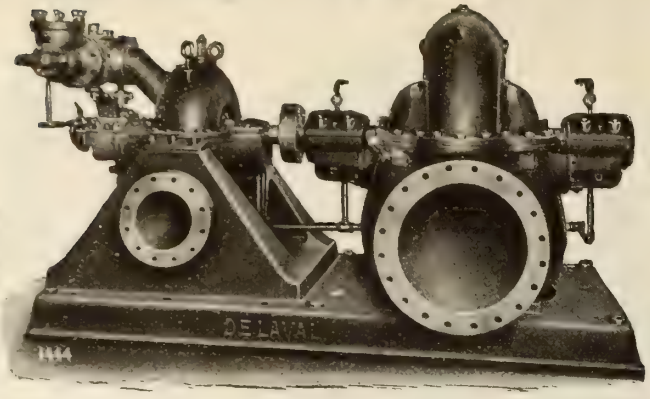

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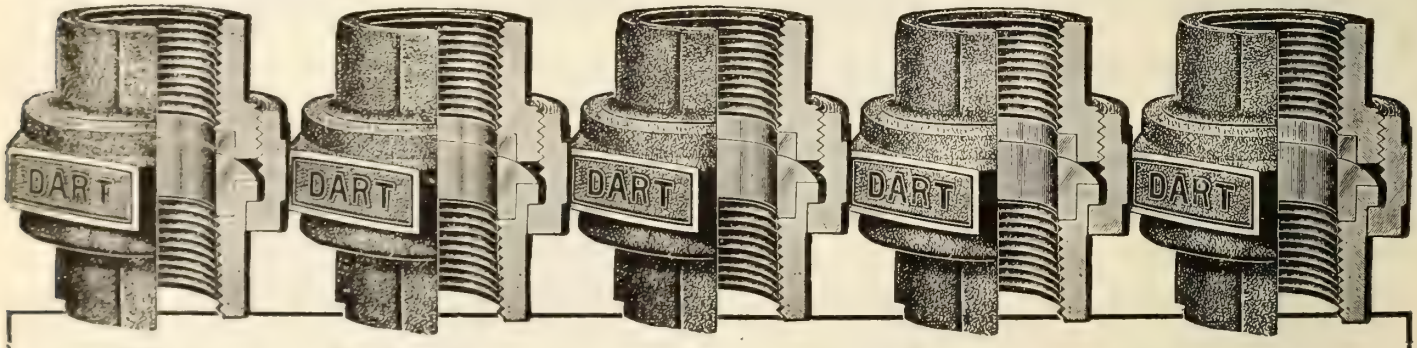

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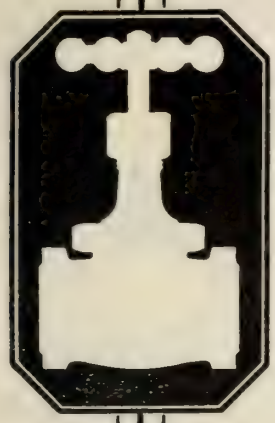

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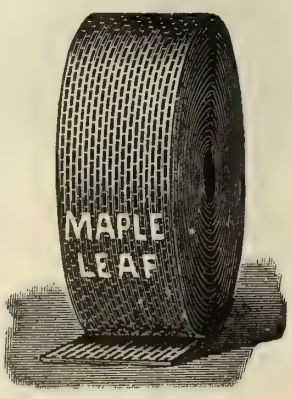

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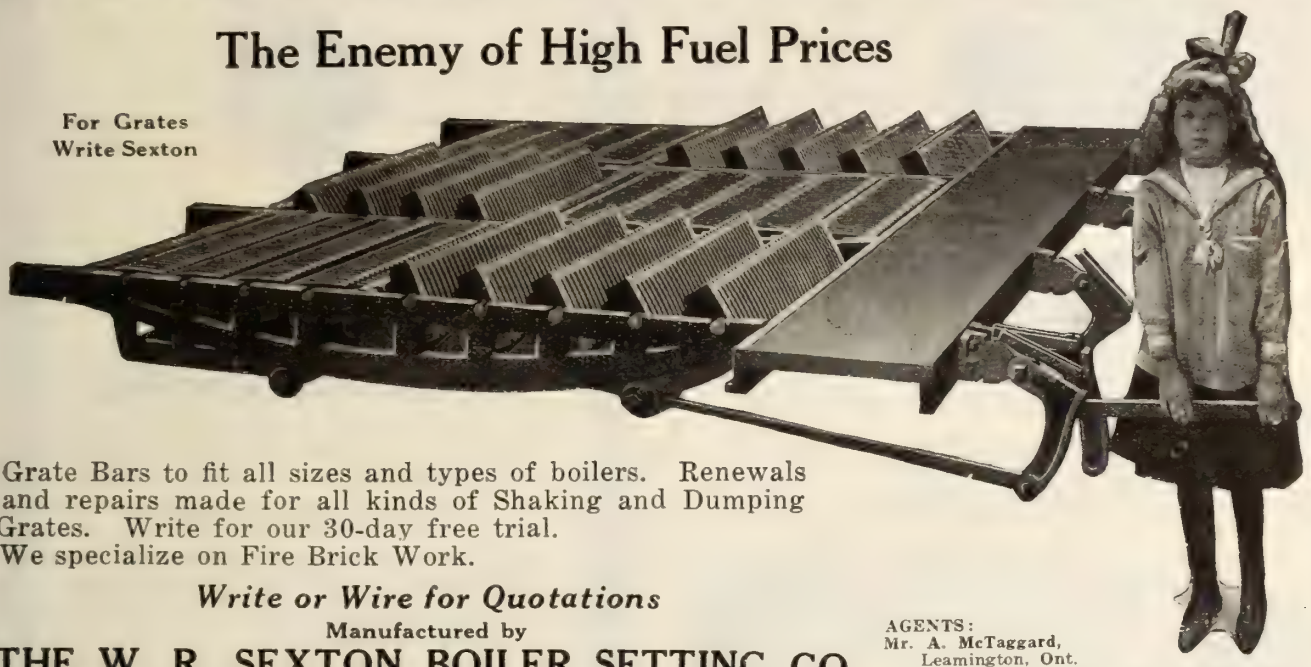

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THE W. R. SEXTON BOILER SETTING CO.
127 D'ARCY STREET, TORONTO

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Gates Engineering, Limited
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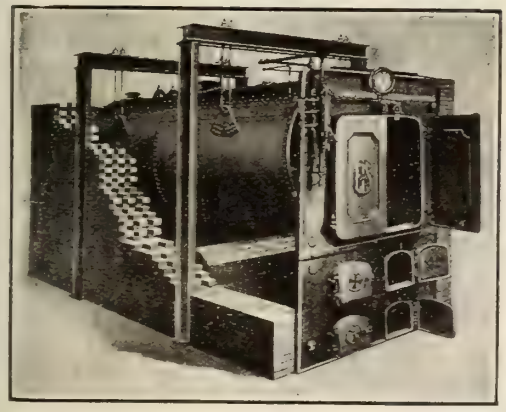

Return Tubular Boiler with Suspension harness for both ends.

We make the following types of Boilers

CONNELLY WATER TUBE
RETURN TUBULAR
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We Specialize in the making of

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TANKS OF ALL TYPES
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LEONARD

Do You Know

that our nearest representative is ready to serve you in every way possible? Whatever your boiler setting troubles, he will make them his study and show you how to remedy them with

PLIBRICO
JOINTLESS
FURNACE LINING

PLIBRICO is a plastic furnace lining, easily applied, that when molded ... side walls, bridge walls, and front and back arches, and properly ... has remarkable strength and durability, outlasting ... many times.

Ask for our Booklet L-45 on "Modern Furnace Building"
PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.
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JOINTLESS
FIRE BRICK CO.
2142 CLAY ST. CHICAGO, ILL.

WILLIAMS' "VULCAN"
Drop-Forged
CHAIN PIPE VISE

The only Pipe Vise made entirely of Wrought Steel

Compact, light, rapid in action and easily attached to bench or post. The strongest and most efficient pipe vise on the market. 3 sizes, for ⅛ to 8 inch pipe.

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"The Drop-Forging People"
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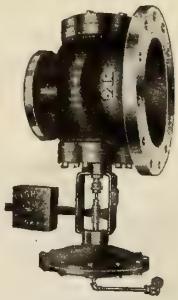

Fisher Reducing Valve
11-A Expanded Outlet

Economical Heating

Economical heating is obtained only when steam is dry and hot, and when no more than necessary is sent through the system.

Fisher Reducing Valve

regulates your steam and delivers to the steam lines only the exact amount necessary to proper maintenance of a predetermined degree of heat.

It will do this automatically—without attention on your part.

The Ingersoll Packing Company, of Ingersoll, Ontario, tell of the long life of Fisher Reducing Valves:

> "We wish to say that the Fisher Reducing Valve we purchased from you in 1904 has been in daily operation since we purchased it and the results we have received have been most satisfactory."

Fisher Steam Trap

will keep your pipe lines absolutely free of condensation. It gives the steam a clear track. There is no leakage in this trap. A perfect water seal is maintained at all times. Because of its extra-large bucket it will operate more forcibly — less frequently. It handles a larger volume of condensation.

Each Fisher Specialty is thoroughly inspected and tested under actual working conditions. This gives positive assurance that they are satisfactory in every way. Fisher Specialties can be ordered from your own jobber—anywhere in Canada.

Write for our interesting book, **"Power Plant Specialties."**

The Fisher Governor Company
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Little Belts, Big Belts and Biggest Belts

Each must do its part in turning the wheels of Industry. Little Belts sometimes drive wheels of vast importance and even Little Belts must be just right to give efficiency; big Belts and Biggest Belts in proportion. We supply some of the Biggest Belts in the Dominion to some of the Biggest Plants in the Dominion.

For DURABILITY and EFFICIENCY Use

"P. M. S" Belting

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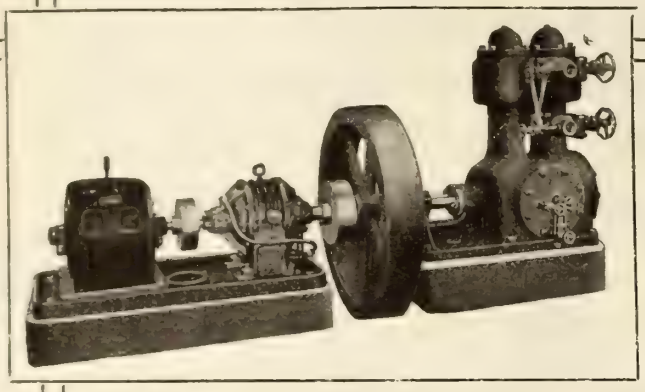
Head Offices and Factory: TORONTO

Branches in all Leading Canadian Cities



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REFRIGERATING MACHINERY

THERE is a YORK Machine to meet every practical condition of Mechanical Refrigeration—in capacities ranging from ¼ ton refrigerating duty upwards.

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Get acquainted with our Sales Engineers. They are competent to give advice, and it is a part of their duty to share our knowledge of the business with any one contemplating the purchase of an Ice Making or Refrigerating Plant.

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Ice Making and Refrigerating Machinery Exclusively
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P&H FLANGED PIPE JOINTS

SCREWED

P.H. LAP

P&H LAP FLANGES, for any service, have proven to be the best yet designed, and they have many advantages over other styles. The pipe is not weakened by cutting into the wall as when using screwed flanges. The gasket bears on the face of the lap and absolutely prevents leakage through the bore of the flange. The hub of the flange is bored slightly larger than the outside diameter of the pipe so that the flange will swivel readily and accommodate itself to any slight variation in the position of the bolt holes, an advantage which is obvious to the fitter and eliminates torsional strains in attaching.

MADE IN CANADA BY

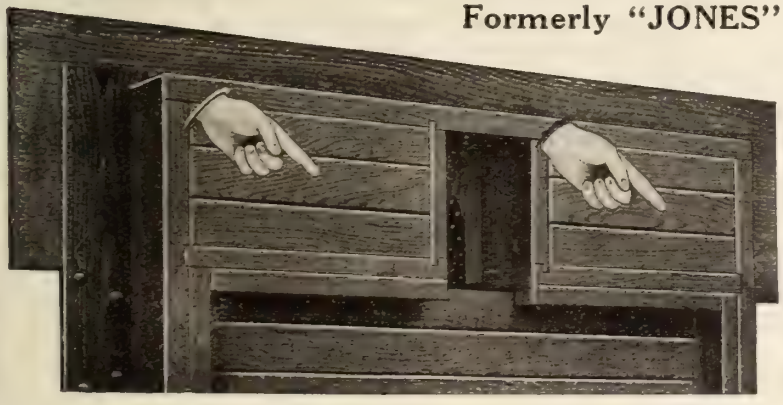
PAGE-HERSEY TUBES, LIMITED

Head Office 100 CHURCH STREET, TORONTO, ONT.

Incomparable JAMISON

Formerly "JONES"

Heavy Duty Cold Storage Doors



Have Many Points of Superior Construction

Note the back of our Standard Track Head Frame with track part; we insulate and finish our track frame heads, an unusual feature. Then note the simplicity of the Track Lift device over the door; no springs or other delicate parts to get out of order. Our Automatic Self-tightening Fastener draws the door rigidly tight each time it is slammed. The hinges too are three to five times heavier than other makes.

These features, and many others, are fully explained in catalog No. 10. Write for it.

JAMISON COLD STORAGE DOOR CO.

Formerly Jones Cold Store Door Co., HAGERSTOWN, MD., U.S.A.

25% More Circulation
—*No Increase in Rates!*

BY UNDERTAKING to fill, for their unexpired terms, all paid-up subscriptions to FARMERS' MAGAZINE—which ceased publication with its issue of February 2nd—MACLEAN'S MAGAZINE has thus added to its list at one stroke, approximately 20,000 paid-in-advance subscribers.

Through the general use of the automobile, the farmer has become to-day practically a suburbanite. Canadian farmers of the class who have been subscribing to FARMERS' MAGAZINE are in a position to buy automobiles, pianos, phonographs, and all other articles or conveniences that make for comfort and a higher standard of living.

Besides being consumers of the best grades of merchandise, they are to-day taking the keenest interest in politics and all public and economic questions.

FARMERS' MAGAZINE and MACLEAN'S MAGAZINE have been the outstanding mediums in Canada, serving separately the rural and urban fields. The decision to discontinue FARMERS' MAGAZINE and to fill the subscriptions with MACLEAN'S, is the result of the maturity of a conviction that the subscribers to our farm magazine are ready now to demand and appreciate a general national magazine like MACLEAN'S in order to have the information and entertainment which they desire — a magazine that will furnish them with good fiction, political articles and Canadian national news of a character not found in the farm papers or newspapers. No change is being made in the physical make-up of MACLEAN'S MAGAZINE, or in the character of its editorial contents.

95,000 Gross Circulation
Rate Based on 70,000 A.B.C.

The addition of FARMERS' MAGAZINE subscription list to MACLEAN'S circulation, after all arrears and duplications are eliminated, commencing with February 15th issue, gives MACLEAN'S MAGAZINE at once a total circulation of more than Ninety-Five Thousand copies each issue.
This gives a big general covering of town and city circulation, plus a highly selected farm circulation. It provides the tremendous influence of the "leadership" families in every city, town and village right across the Dominion, together with the most prosperous and progressive farmers in each trading territory; and constitutes a service which is not equalled or even approximated by any other general publication in Canada.

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**MACLEAN'S is the outstanding,
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"CANADA'S NATIONAL MAGAZINE"

Most Talked of Publication In Canada

The MacLean Publishing Company, Limited, 153 University Avenue, Toronto, Ont.

The MACLEAN Stoker

TRADE MARK REGISTERED

Will start right in to save you money from the day it is installed!

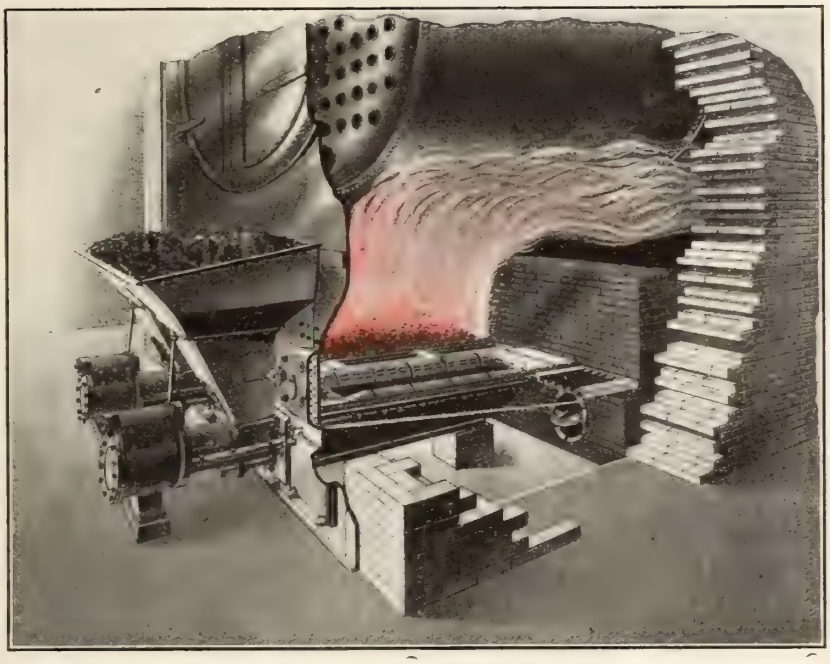
It immediately takes care of one of the biggest problems confronting the plant engineer, viz., **production of steam at lowest cost.**

The MacLean Stoker is adaptable to practically every type of boiler and to all classes of steam plants. Canning Factories, Rubber and Tire Plants, Pulp and Paper Mills, Laundries, Tanneries, Woollen Mills, Dye Houses, Public Institutions and Office Buildings are typical installations where large reductions in the coal bills are a sure result.

There are many reasons why your next stoker should be a MACLEAN. It has the construction that is dependable and essential to boiler plant equipment.

Look over the features stated and write us for fuller details.

MACLEAN UNDERFEED STOKER CO.
LIMITED
95-97 King Street E. TORONTO



A constant uniform steam pressure is carried regardless of varying loads on the boilers.

A smokeless chimney is maintained. Will not infringe the smoke by-laws of any city—anywhere!

Coal consumption is reduced.

Responds automatically to sudden demands for steam.

No siftings of unburned coal to the ash pit because there are no grates.

The steaming capacity of the boilers is increased.

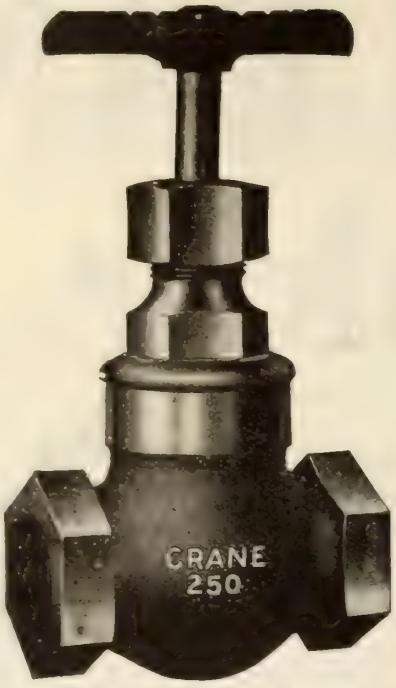
Cleaner Tubes and heating surfaces due to clear combustion.

Small cost of upkeep on account of the simple construction. There is **not one** moving part in contact with the fire.

No special brickwork is needed.

Easy to install, easy to operate—No previous knowledge of stokers is required.

Soon Pays the Cost of Installation



No. 60 E

CRANE

Extra Heavy GLOBE and ANGLE VALVE with Copper Disc

The Crane Copper Disc successfully overcomes the many objections found in some types of hard rubber or composition discs. The construction of the disc and holder is such that the disc may be easily taken out and replaced.

For 250 pounds steam working pressure

Tested to 800 pounds hydraulic pressure

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INDICATING, RECORDING & CONTROLLING

It is the faithful performance of the exacting duties of power plants that has established the prestige of Tycos Instruments. Their reputation rests upon the knowledge that there is a Competent Tycos Instrument for every temperature problem in the boiler or engine room.

Temperature needs are summarized in a concise and convincing manner in Tycos catalogs. Send for them.

Taylor Instrument Companies

110-112 Church St., Toronto

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THERE'S A *Tycos* OR A *Taylor* THERMOMETER FOR EVERY PURPOSE

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FLEXIBLE METALLIC PACKING CO.

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AGENTS:

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The TURBINE Furnace

Results of Test on No. 3 Boiler at P. Burns & Co., Vancouver with COKE DUST or BREEZE

Duration of Test	6 hrs. 30 min.
Weight of Fuel Used	4,000 lbs.
Equivalent Evap. per hour	4,326 lbs.
H.P. of Boiler	144
Lbs. of Steam per lb. of Fuel from and at 212° F.	7
Lbs. of Coke Breeze burned per sq. foot of grate per hour	30.43

Moisture, 8.9%; Ash, 22.72%; by analysis.

Agent For Canada

PERCY A. GOEPEL

525 Pender St. W., Vancouver, B. C.

Power Plant Equipment

NEW AND USED

Petrie believes that selling **Satisfaction** is every bit as essential as selling **Machines.**

Tanks—any size, any capacity, up to 2,450 gals.

Marine Boilers—Internal Fired

Horizontal Boilers from 6 H.P. to 200 H.P.

Firebox Boilers
From 12 H. P. to 60 H. P.

Vertical Boilers
From 1 H. P. to 75 H. P.

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From 2 H. P. to 75 H. P.

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From 5 H. P. to 250 H. P.

Automatic Engines
From 15 H. P. to 450 H.P.

Write for prices and complete particulars

H. W. Petrie, Ltd.

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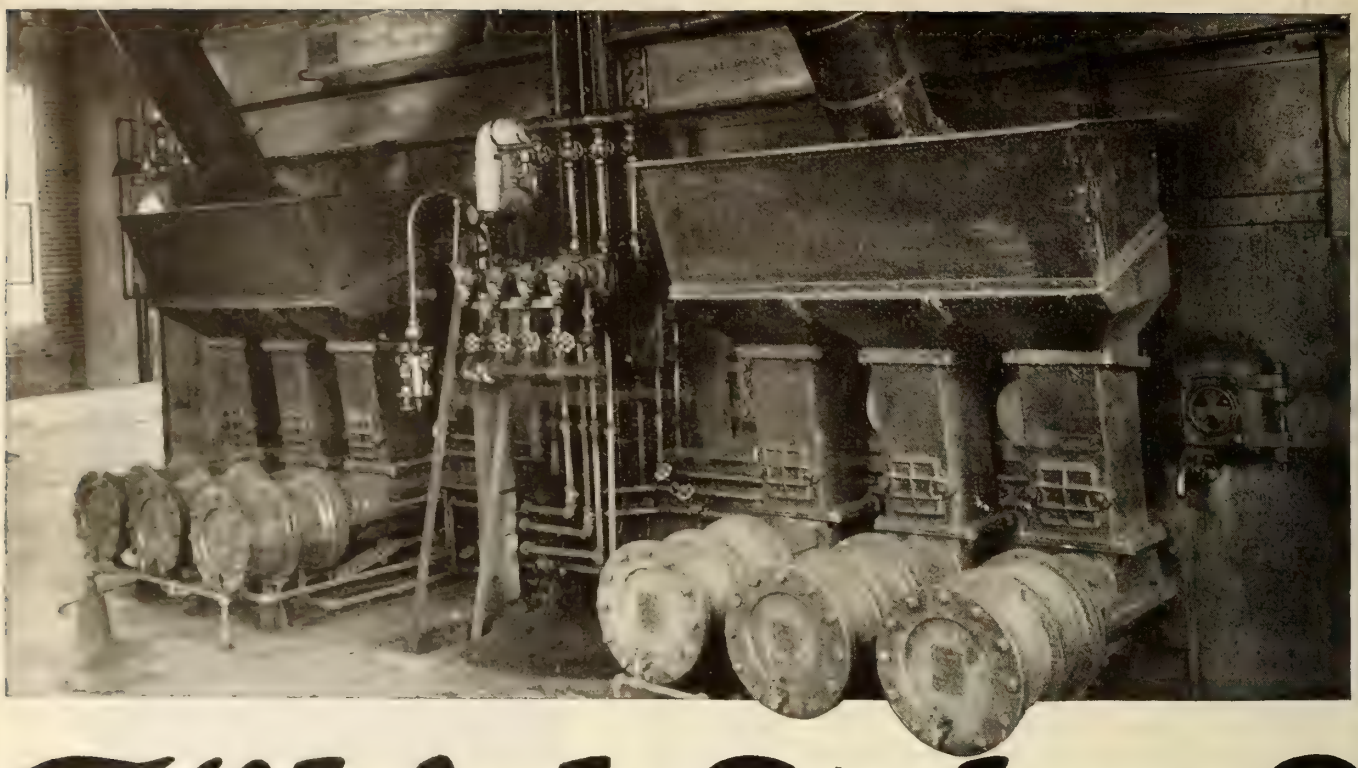

Which Stoker?

—You Make this Decision Once—It Must be Right

EXPERIMENT with any equipment is costly—but experiment with mechanical stokers is out of the question. The investment is large; it is made once in a lifetime; snap judgment won't do—*which stoker?*

Canadian plants want greater boiler capacity—continuous power day and night when necessary—they want this accompanied by greater economy in burning Canadian coals and by lower labor costs.

This means *high-duty stoker firing,* best exemplified by the Jones "A-C" (Automatic-Cleaning) Stoker.

Regardless of the size of the plant, the grade of coal burned or the local conditions to be met, the logical, safe answer to *"which stoker?"* is Jones "A-C."

The new "A-C" catalog goes into detail. Jones engineers with unmatched experience in this specialized field, will gladly make a survey of your plant and give you the full benefit of the best they have learned in installing stokers in many prominent power houses. Investigation implies no obligation.

The Canadian Stoker
Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. Through special arrangement the extensive engineering resources of the Under-Feed Stoker Co., of America are made available for Canadian power users. Thus, this strictly Canadian stoker is backed by world-wide experience and unequalled engineering ability.

The Under-Feed Stoker Co. of Canada, Ltd.

81 Victoria Street, Toronto

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Mr. J. Twomey, Camrose, Alberta.
Manitoba:
W. W. Hicks & Co.,
567 Banning St., Winnipeg.

British Columbia:
E. A. Earle, Limited.
729 Hastings St. W.,
Vancouver, B. C.

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The Cleaton Co. (Canada), Ltd.,
403 Southam Bldg.,
Montreal, Que.

JONES "A-C" STOKERS

Put these three to Work

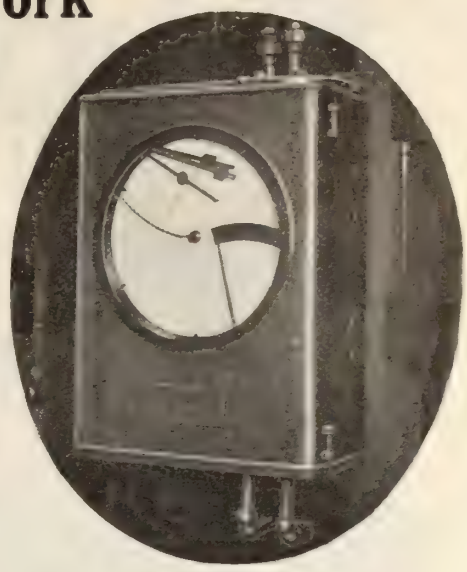
For Maximum Boiler Room Efficiency

Give your fireman the new BAILEY Multi-Pointer Gauge, equipped with enough separate pointers to instantly make any amount of draft readings. Back that up with a BAILEY Boiler Meter and a BAILEY Ash Pit Loss Recorder and you can rest confident that every boiler room leak is instantly recorded or indicated. Write us for descriptive bulletins.

Three Pointer Gauge for wall mounting. Made for as many as twelve pointers.

BAILEY
Ash Pit Loss Recorder

Bailey Meters are Made in Canada



Bailey Boiler Meter. Records steam flow, air flow and flue gas temperature all on one chart.

Bailey Meter Co. Limited **177 Delorimier Ave., Montreal**

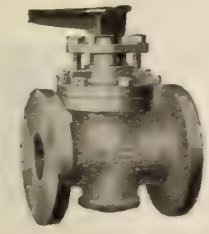
HOMESTEAD

Quarter-Turn Valves

Economy!

A valve to be economical must give dependable, lasting service.

Homesteads open and close easily. The patent balancing parts insure it against sticking. When the Homestead is fully opened, the two surfaces which are depended upon for tightness are in no way affected by the material passing through. The plug cock provides a straight-way opening which is desirable in all sorts of work but particularly so in high pressure service—also in the handling of thick heavy liquids.



Elimination of waste time and leakages quickly pays for all Homestead valves. You would do well to adopt them without delay.

Homestead Valve Mfg. Company
Homestead, Pa.

USE

BETSON'S
REG. U.S. PAT. OFF. TRADE MARK CAN. PAT. OFF.
PLASTIC FIRE BRICK

IN THE HEART OF YOUR PLANT

Build permanent, properly flared, one-piece boiler arches and walls without any bricks to fall out. Betson's Plastic Fire Brick eliminates frequent shutdowns for repairs, prevents inleakage of cold air. Any man can build one-piece arches and make perfect furnace linings with Betson's Plastic Fire Brick.

Write for informative booklet for boiler room use

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P.O. Box 386-6, Rome, N.Y.
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44-6 Lombard Street. Toronto, Ont. Canada
If it isn't BETSON'S it isn't Plastic Fire Brick

McGowan Duplex

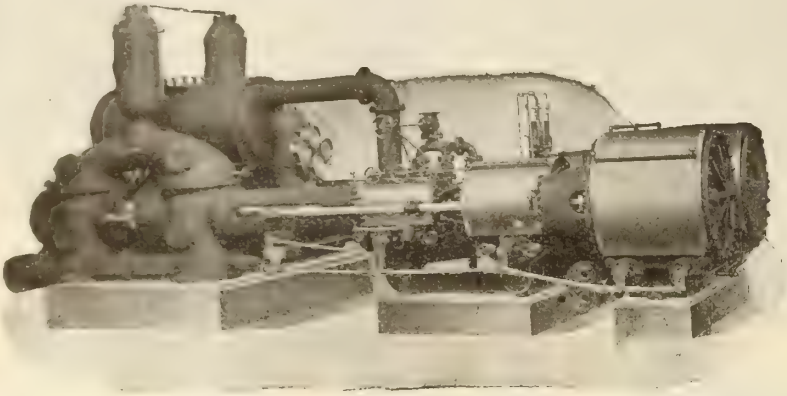


FIG. 7362
Water Works Pumping Engines; capacities up to 5,000,000 gallons per day.

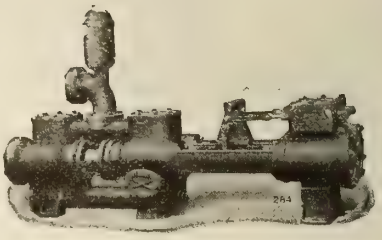


FIG. 7284
Outside Packed Plunger Duplex Steam Pump. Steam Pumps for all commercial purposes.

FIG. 7242
Outside Packed Plunger Types up to capacities of 3,500 gallons per minute.

Proof of Pump Economy

Obtain the greatest economy from your pump investment by insisting that the Steam or Power Driven Pump you purchase is a McGowan; **built to uniform specifications of the highest standard** with all parts readily interchangeable.

Thus there is a double advantage in choosing McGowan Pumps; longer service and quicker repair facilities—all at a moderate price considering the high quality materials and workmanship.

We will be pleased to receive your inquiries.

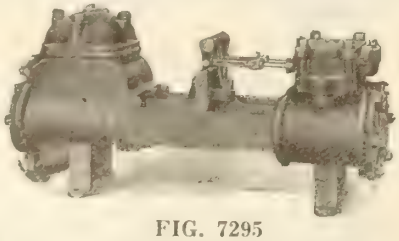
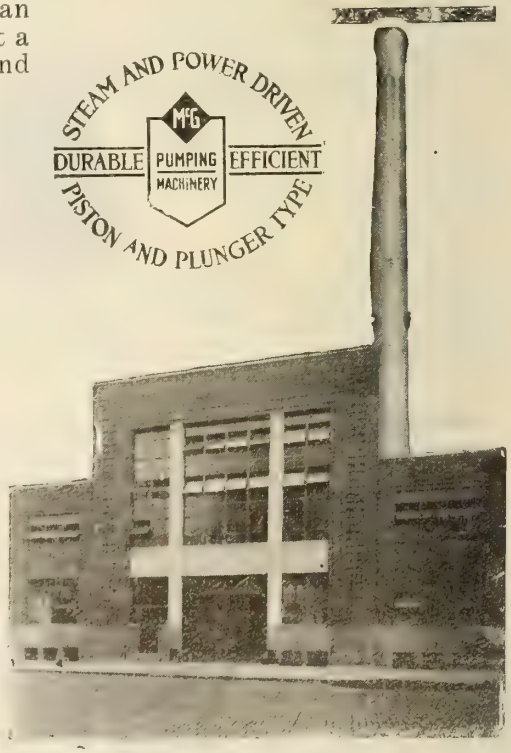


FIG. 7295
Packed Piston Boiler Feed Pump.

STEAM AND POWER DRIVEN
DURABLE PUMPING EFFICIENT
PISTON AND PLUNGER TYPE
MG PUMPING MACHINERY



The John H. McGowan Co.

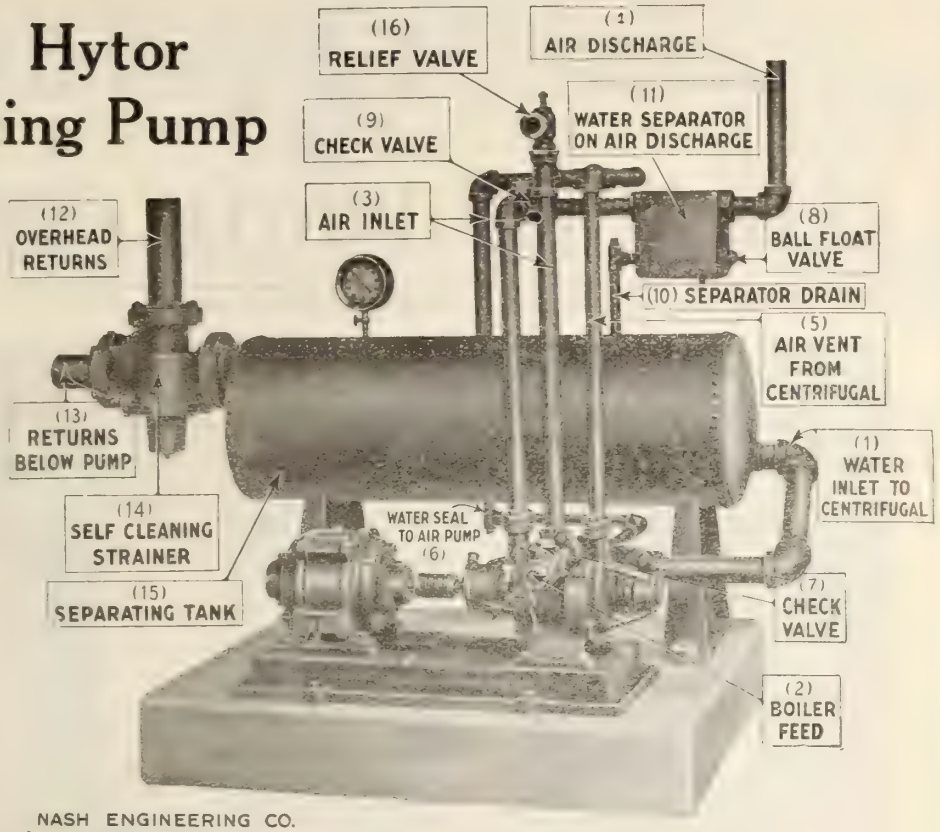
Cincinnati, Ohio

General Offices and Works:

54-56 Central Ave., Cincinnati, Ohio.

The Jennings Hytor Vacuum Heating Pump

THE ADVANTAGES of vacuum in connection with steam heating are well understood, but in installing equipment consideration should be given economy, efficiency, and durability. In these respects the **Jennings Hytor Vacuum Heating Pump** deserves careful attention. It is distinctly in advance in principles of design compared with other types; principles of design which assure reliability, perfect service and low up keep cost. Another feature is compactness, and the horsepower required for its operation is less than half that consumed by other vacuum heating pumps of similar capacity. **Study the illustration, then write for catalog.**

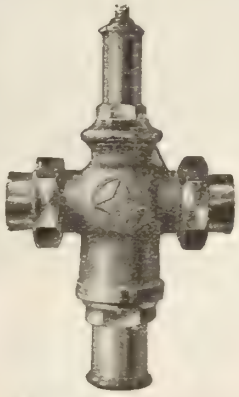


The Arthur S. Leitch Co., Ltd.

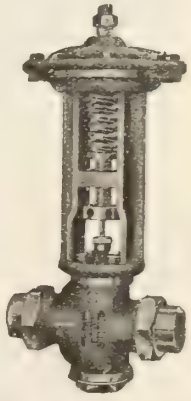
1001-2 Kent Building
TORONTO

NASH ENGINEERING CO.
SO. NORWALK, CONN. U.S.A.

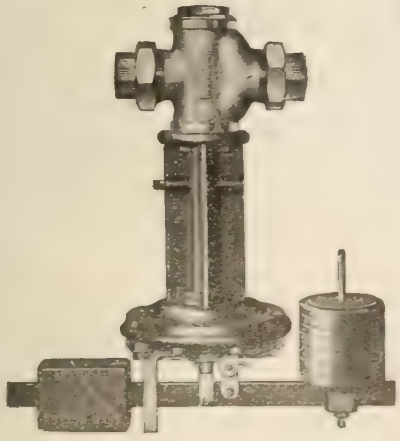
MASON STEAM SPECIALTIES for Service



Mason Standard Reducing Valve, ½" to 2" Bronze Body.

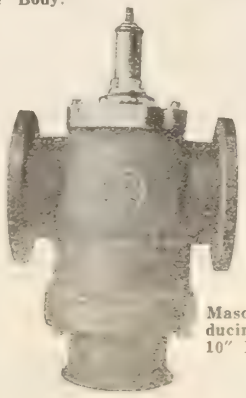


Mason No. 55 Pump Pressure Regulator.



Mason Balanced Valve with Weight and Lever. Self closing for controlling pumps, engines, etc.

THE many types of Mason Standard Reducing Valves and Pressure Regulators offer the engineer an immediate means of obtaining exceptional service — no matter what the trouble. Place orders with our nearest branch.



Mason Standard Reducing Valve 2½" to 10" Iron Body.

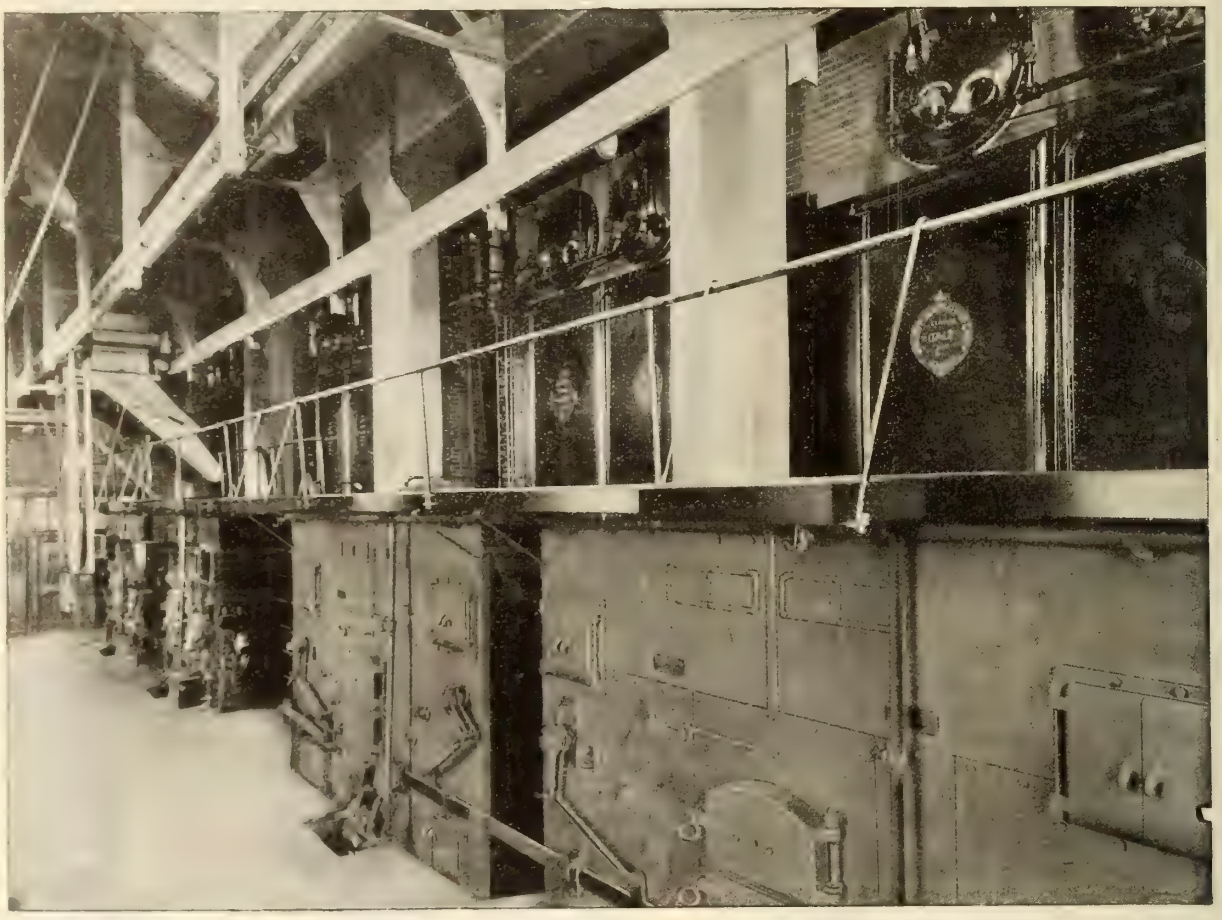
The Mason Regulator & Engineering Co., Limited

Head Office and Works: 135-153 Dagenais St., Montreal, Que.

Toronto Office: VALVE ENGINEERING CO., 160 King Street West.

Agencies at: QUEBEC, HALIFAX, ST. JOHN, WINNIPEG AND VANCOUVER.

DEPENDABLE POWER EQUIPMENT



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The Power Plant Journal of Canada

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The Power Plant of the King Edward Hotel

Our Readers Are Taken Down Into The Basement and The Inner Workings of the Power Plant and All Its Contingent Apparatus Laid Open For Their Inspection

By T. H. FENNER

By permission of Mr. G. H. O'Neil, General Manager, United Hotels, Ltd.

THE CITY of Toronto has a habit of being proud of its features, and of itself as a whole. When hotels are mentioned in Toronto the King Edward is naturally though of as being the biggest thing of its line in the city, and its new eighteen-story building is a prominent feature of the landscape, or rather skyscape, for visitors entering Toronto by boat.

A hotel like this, which contains within its walls between guests and staff, enough people to make a little country town, has to be able to attend to their needs and fancies in a pretty wholesale way, and its services must never be allowed to slack off, on any excuse whatever. It must be lighted, heated, ventilated, and cooled, every minute of every hour of every day in the year.

A factory can be closed down at night, and at week ends, and any needed repairs or alterations carried out with some reasonable allowance of time. A hotel can never close down for a minute. The demand therefore on the machinery and staff that are responsible for its upkeep, is a never ceasing one.

Day in and day out, year to year, the ever-ready current must be on the wire to flash into light when the impatient guest turns a switch, the water must be hot in the tap when he turns on his bath, the ice must be ready to cool off his drinking water, the elevator must be running to take him upstairs or down.

In addition to these things which are apparent to the sight and touch, there are many others which are necessary to his comfort, but with which he never comes in contact. His room is cleaned and swept by the same willing current which lights his lamp, and operates his telephone. His food is kept fresh and sweet in refrigerated store rooms, ice cream is frozen by brine from the same refrigerating machines, and the ice for his ice water is another product of the plant. There are the freight elevators which bring up his baggage, the existence of which he is probably not aware, but they also are driven by the current which comes from the lowest depths of the building. The guest takes all these things as a matter of course, and it is safe to say that perhaps not one half of one per cent. of them ever give a single thought to the means by which all these things are provided to their hand.

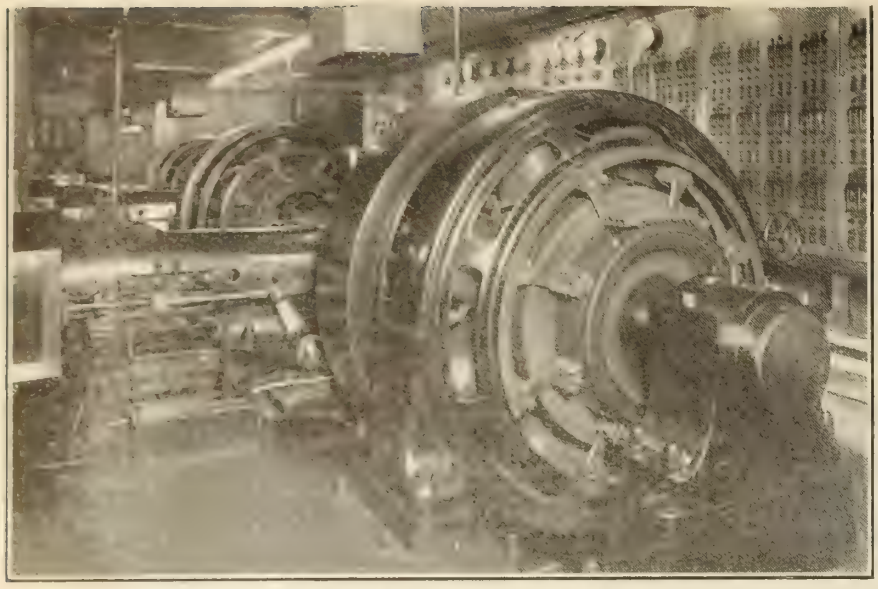
The Hidden Power

Down below the level of the street, part of it even forty-five feet below, is the plant which daily performs these miracles. One could be in the kitchen next door to it and not know of its existence for there is neither sound nor smell to tell that there are engines producing power and light, and refrigerating machines making ice, and boilers generating steam to supply power and heat, just through an ordinary door. The thing that cannot help striking the observer, is that this same note of quiet efficiency pervades the whole plant. No one seems to hurry, no one raises his voice, and the work goes on with a great deal less fuss than can often be seen in the boiler room of a one-horse saw mill.

It can readily be understood, that the provision of an entirely new building, with all these services to be installed, the while all the functions of the old building went on undisturbed, was somewhat of a problem. However, by ample foresight, and careful preparation for every move, the entire new installation was installed and connected up without anyone outside of the power plant knowing it was going on. No guest suffered a moment's inconvenience, and the fact that the new building was just about ready by the time the heating season came on made it all the more important that the system should be ready to function immediately it was called on. It was able to fulfill this condition, through the efforts of all concerned, contractors and staff alike.

The original plant of the hotel, which is operating to-day, consists of three Babcock & Wilcox watertube boilers,

The original switchboard. The new interconnecting board is at the far end.



One of the main generators.

of 250 h. p. (rated) each. These boilers supplied steam to the engine room, the kitchen, and heating system, and to some extent are doing the same thing at present. Eventually these boilers will be discontinued, when the new plant is completely installed, but just now they are doing business as required.

In the old boiler room are the original vacuum pumps and boiler feed pumps, and the original Webster heater, supplied by Darling Bros. The vacuum pumps are of the Burnham type, made by Darling Bros., and are two in number. One of them is 10 x 4 x 16, the smaller one being 8 x 10 x 12. These pumps are so arranged that either of them can operate on the heating system alone, while the other handles the kitchens and laundries, or they can either of them handle the whole thing.

The main steam header from the boilers is arranged to supply the engines and refrigerating machinery, and can also supply the heating services. In addition to this there is a 4 inch auxiliary line, which is also connected, as a loop leaving the main header free for any necessary repairs.

The old boiler plant is now connected up with the new one, but we will refer to this phase later.

The boilers are fed by two Burnham, outside packed, horizontal feed pumps, drawing their water from the Webster open feed heater.

We had the pleasure of looking in the top drum of one of these boilers, which was down for cleaning, and we can safely say that never have we seen a boiler in better condition after eighteen years of service. The plates were smooth and showing just a suspicion of shine, due to the judicious use of graphite. [illegible] after such long service as it must using exhaust steam for [illegible]. Mr. Pike is very proud of his boilers, and has good cause to be.

Proceeding from the boiler room, we extends across the front of the building. The photographs here reproduced will give a good idea of the layout. The units in detail are as follows. No. 1 generator, 225 volts, 200 amps, 270 r. p.m. direct connected to Robb Armstrong horizontal engine.

No. 2 generator, 225 volts, 400 amps, 260 r.p.m. direct connected to Robb Armstrong engine.

Nos. 3 and 4 generators, 225 volts, 625 amps, direct connected to Robb Armstrong horizontal engines.

Two motor generator sets transforming two wire to three wire distribution.

Two Linde British 30 ton ammonia compressors, direct driven by Wheelock steam engines, providing cold storage and icemaking for the entire hotel. About 4 tons of ice is made per day in addition to the cooling of store rooms and making of ice cream.

The generators mentioned above supply current to the main switchboard from whence it is distributed to the various circuits throughout the building. There is also a connection from the wires of the Toronto and Niagara Power Co., coming in on the same board, so that the services of the hotel can be supplied either by their own plant or the outside power.

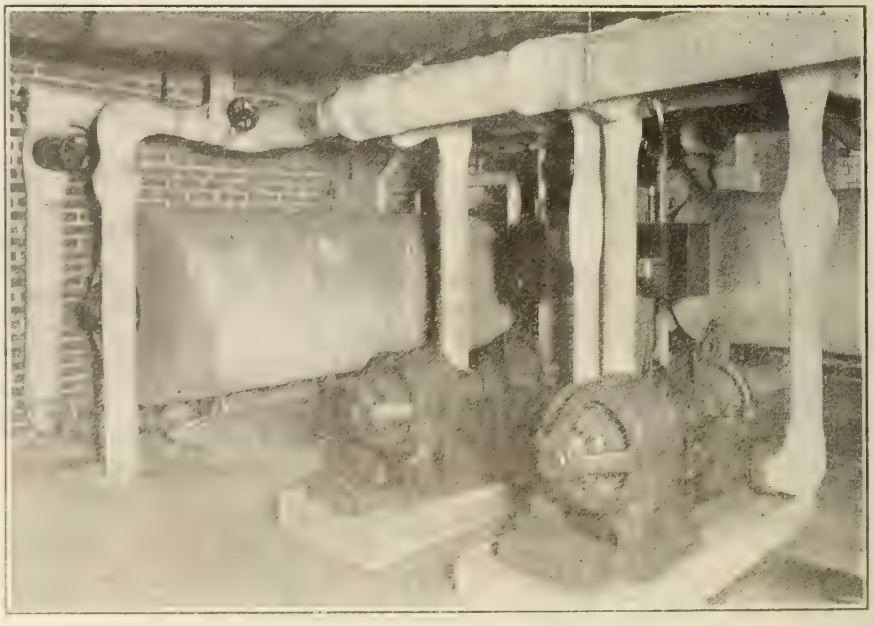
In connection with the necessary current for the new building, and the tying in of the hotel plant and the outside power to procure the necessary flexibility, a large amount of work was entailed. This included installing a new underground service from the T. N. P. Co.'s station at Scott Street, to a manhole on Colborne, near Victoria Street, from which the wires are taken into the hotel basement, and connection made to a two-pole switchboard. This switchboard is of slate, two inches thick, and contains two panels.

The cables carrying the supply from Scott Street consist of three 1,000,000, C. M. lead-covered cables parallel to each leg. The No. 1 panel of the board mentioned above carries a 1,500-Ampere 260-Volt 3-pole D. C. industrial type Roller Smith circuit breaker for light and one 2,000 Amp. 250 Volt D. C. circuit breaker for power, same type.

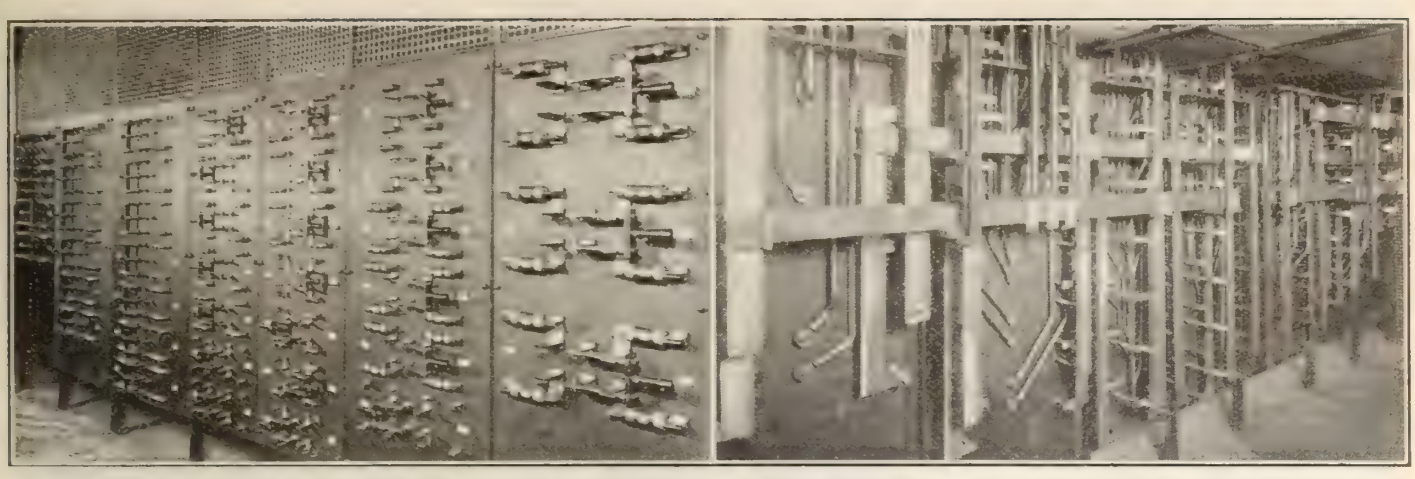
The second panel contains the necessary power and light meters for the services of the T. N. P. Co., including a graphic meter with the necessary shunts. From this board the necessary cables are carried over to the distribution board in the engine room. This switchboard carries one 1,000 Ampere, 250-Volt 3-pole circuit breaker for the new switch board, one 300 Ampere 3-pole 250-Volt breaker for the old switchboard, and also one 600 Ampere 3-pole 250-Volt breaker which ties in the present generator switchboard panels to the new distribution board.

On a second panel of this same board are carried the three corresponding power circuit breakers.

This switchboard, then, affords a



[illegible] hot water heaters, and motor driven centrifugal house service pumps, installed by Darling Bros.



Front and Back View of New Distributing Switchboard For New Build ng. Board Made By Drive Switch Co., Under Instruction of Ramsden and Roxburgh, and Otto Goldschmidt (Consulting Engineer.)

means of putting the T. N. P. Co. current onto the old switchboard, and the new switchboard at the east end of the engine room. It also allows the current from the generators to be put on to the new switchboard, and allows a means of balancing the load from the hotel's own generators and the outside current in any proportion required by the operating staff. It also precludes any possibility of a failure of current, as there is always the alternative of the T. N. P. Co. power and the hotel's own. As the hotel has four generators, the possibility of a complete failure of current is so remote as to be outside the bounds of probability.

The distributing board just mentioned was made by the Benjamin Electric Co., to the design of Messrs. Ramsden & Roxburgh, the general contractors for all the electric work necessary.

The new switchboard for supplying the new building which is shown in our illustration, both a front and back view being given, was supplied by the Devoe Electric Co. of Montreal, to the design of Messrs. Ramsden & Roxburgh. It contains 7 panels, and is arranged with double throw switches for either hotel power or T. N. P. Co. power.

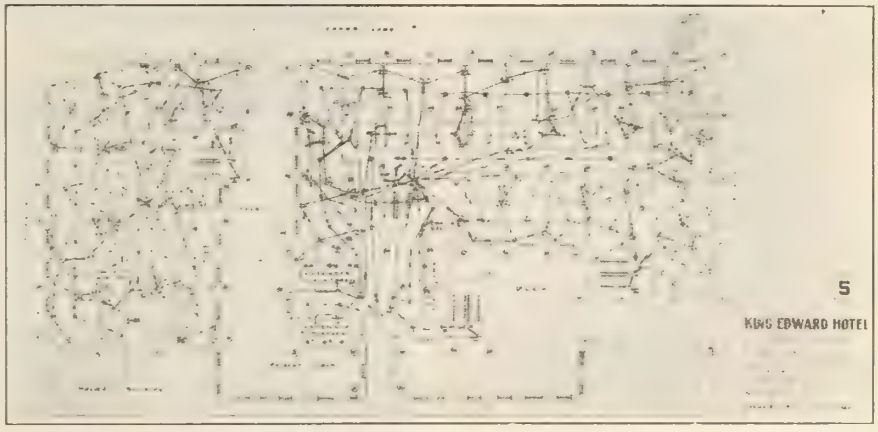
A new type of construction has been adopted for the connections between the switches and cable box. Instead of following the usual practice of connecting the cables directly into the switches, the cables terminate in a box above the switchboard, which runs the whole length of the board. Connection is made between the cables and the switches by means of copper connecting rods. This enables a much neater general finish to the back of the board, as the connecting rods are all uniform. It also allows of an easy means of increasing the section of the connections if required at any time.

The photograph reproduced gives a very good idea of the general appearance of the back of this board.

Just above where the connecting rods terminate, and on the bottom side of the cable box there is a slate slab which serves the purpose of holding the connecting rods in place and also provides a split lug for the cables. There is a bronze grille which can be seen in our illustration entirely surrounding this cable box. In the building itself there are five panel boards for power distribution and 53 panels for lighting. These panels vary in size from 4-circuit to 32-circuit. They were constructed to the instruction of the consulting engineer, Otto E. Goldschmidt, of New York, by the Devoe Electric Switch Co.

Some idea of the size of this job may be gathered from the fact that 120,000 feet of conduit and 315,000 feet of wire were used. No less than 20,000 locknuts and bushings, while receptacles and outlets of various types amounted to 35,000.

The total connected load is in the neighborhood of 650 h.p. divided between the two buildings as follows: in



Plan of wiring arrangement for lighting system on one floor of new building.

he new building there is 300 k.w. lighting and 375 k.w. power load, and in the old building, 200 k.w. lighting and 115 k.w. power.

An idea of the lighting distribution can be gathered from the reproduction of the wiring plan shown here.

House Service Water

At the east end of the engine room, after passing the ammonia condensers and the new distributing board for the new building, one reaches the hot water heaters and also the house service pumps.

It is necessary in a building of this height to provide other means than the ordinary city water pressure to supply the upper floors, otherwise they would go without. The height from the engine room basement to the gallery where the water tanks are situated is approximately 220 feet, and as this corresponds to a pressure of 95.48 lbs., it can be understood that it is beyond the reach of the ordinary city water works pressure.

In order to insure a constant supply of water to the rooms, two house service pumps are fitted in the basement which are controlled automatically by the water level in the tanks on the roof. These pumps are of the type known as Darling Class B, centrifugal, direct connected to motors. The illustration shows the arrangement plainly. These pumps are designed to deliver not less than 200 gallons per minute each under the conditions prevailing, which are, of course, a suction pressure corresponding to the pressure in the city mains, and the discharge due to the head water. The float controls are so arranged that the higher float will first start one pump, and then if the water still drops, a second float will start the second pump. As the water gains the pumps

will be cut out in the reverse manner the lower float cutting out the second pump started, and the upper one cutting out the first pump when the water level is regained. It may be mentioned here that the consumption is over 200,000 gallons per day. It has been observed by actual timing, that from the time the float trips the control until the water is being delivered into the tank, is exactly eleven seconds. This is pretty nearly as quick as thinking.

The hot water heaters contained in the same room as the house service pumps are also shown in the photograph. The large one is a Darling-Whitlock combined hot water heater and storage tank, 48 inches in diameter by 168 inches long, inside measurement, with a storage capacity of 1,350 gallons. The shell is of steel ⅜-in. plate, the longitudinal seam being double riveted. The heating surface is provided by 450 feet of 1¼ in. outside diameter No. 16 gauge seamless drawn brass tubing. The tubes are U shaped, and both ends are expanded into a forged steel header, which is bolted to the steam expansion chamber. The overhanging ends of the tubes are supported in such a manner as to take the strain off the neck where they are expanded into the header.

The steam connection to this header is 5 in. and a 2-in. drip is provided for the condensation. The tank is fitted with relief valve, thermometer, Power's automatic regulator, etc.

In addition there is a smaller heater for supplying the laundries and kitchens, 42 inches diameter by 120 inches long, and containing 720 gallons storage capacity. The heating surface in this heater consists of 300 feet of 1¼ brass tube No. 16 gauge, and the same fittings as the larger one.

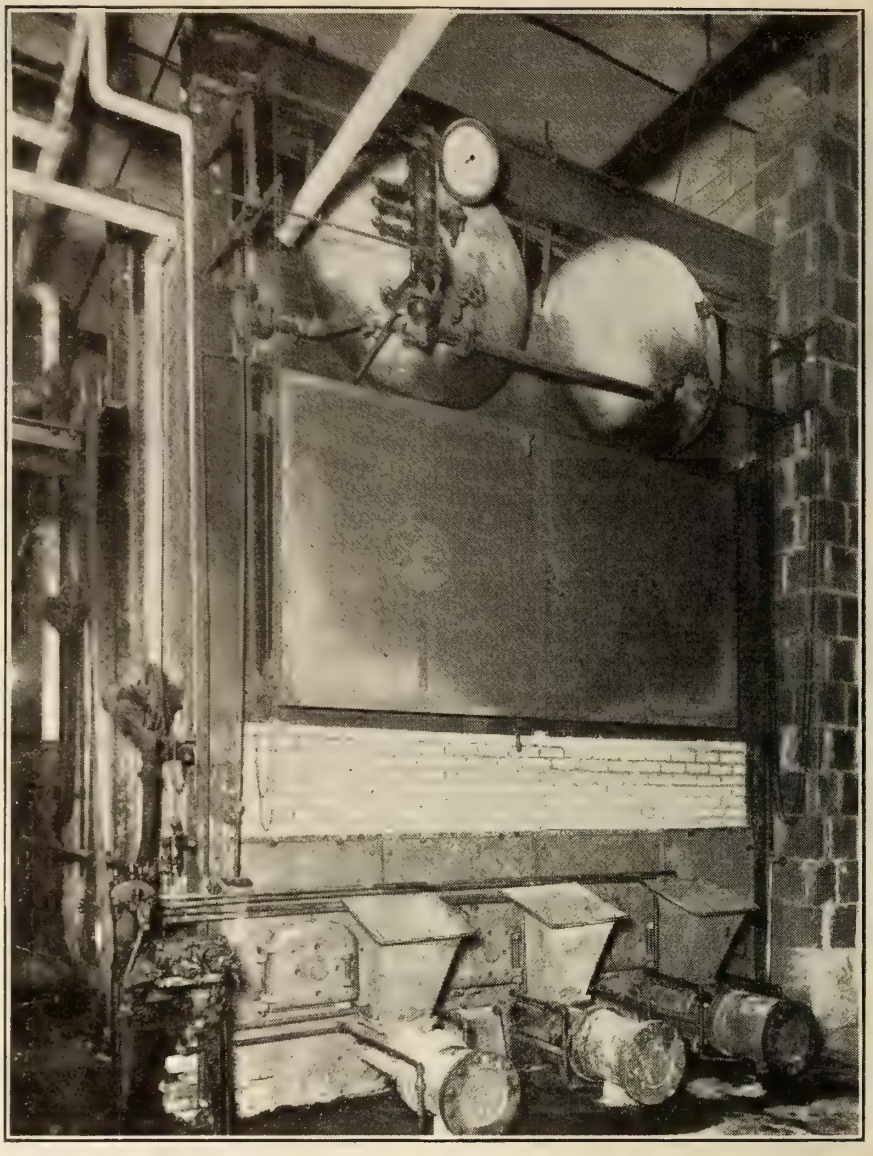
The drips are arranged to be carried either to the vacuum pumps or to the sewer, as may be required.

The New Boiler Room

Leaving the pump and heater room, we journey through a corner of a kitchen, absorbing an odor of savory soup in the process of boiling in huge copper kettles, along a corridor, round two or three more corners, meekly following our guide, until we arrive at the head of a staircase. As we are already in the basement, it looks as though there must have been some considerable excavating done when we have more stairs to go down.

This is the case, as we find. The new boiler room floor is just forty-five feet below the level of the sidewalk, and quite a long way from the engine room and the original boiler room. If the plans had been carried out as originally conceived, or as they will eventually be carried out, this isolated position would not matter, but as things are, it involved a good deal of trouble.

The new boiler room was designed to contain four boilers, and these four boilers were to take off all the load from the boiler plant, which would then be obsolete.



Front View of New 400 H. P. B. & W. Boiler, and Jones Stokers.

The new plant when complete is to consist of three 250 h.p. Babcock & Wilcox boilers and one 400 h.p. of the same type. At present the 400 h.p. is the only one installed. This is a case where the engineers propose, but the financiers dispose, and for the time being these gentlemen decreed one boiler only.

Had the original plans been carried out immediately, it would have meant that one day the new piping could have been connected to the old main steam pipe in the engine room and the old boiler room and its connections from the engine room back could have been cut off, and dismantled at leisure.

As it turned out, the two plants have had to be interconnected, so that the new 400 h.p. boiler at one end of the building is working in connection with one of the old 250 h.p. boilers at the other end of the building. The new boiler is considerably below the level of the old boiler in addition to being so far away from it. This of course involves operating difficulty, when the vacuum return system is remembered. If the operators in the new boiler room do not observe good care, they will take all the returns from the whole building, and leave the higher boiler with no hot water for feed purposes. However, the men in the new boiler room manage very nicely to check off their pump sufficiently to keep the other fellows going without any trouble.

The piping arrangement in the new boiler room, installed for the heating contractors by W. J. McGuire, Ltd., can be fairly well seen by the illustration herewith. There is one showing the main steam pipe leaving the boiler top and coming down in two very nice expansion bends to the header, which goes across the boiler room to the main riser.

From the boiler the main steam also goes across to the engine room, where it connects to the header supplying steam to the engines, and also by a branch through suitable reducing valves to the heating main. In this way steam can be supplied to the engine room or the heating system from either boiler room.

The main riser which is fitted with Vanstone expansion joints, this type of joint being used throughout, goes right

up to the sixteenth story, to a pipe gallery. Here it connects into a horizontal main on the ceiling, from which branches are dropped to each floor to supply the radiators. This overhead distribution system is used entirely in the new building.

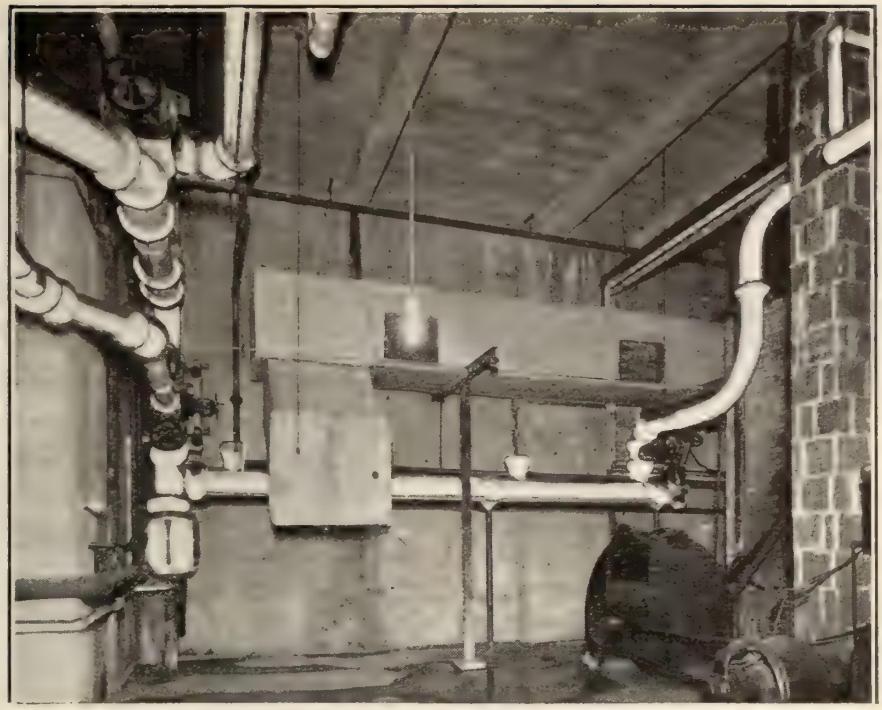
The returns from the radiators come back through risers into a four-inch main which connects with the vacuum pumps. The vacuum pumps discharge into an air eliminating tank which is situated on a gallery above the feed water heater. This tank is 36 inches diameter by 84 inches long. From the tank the water discharges through a water seal into the feed water heater, an automatic float being fitted to keep the water level constant. From the top of the tank an air pipe is led to the roof to discharge the air which is separated from the return water.

The feed water heater in the new boiler room is a Webster Class E. B. "Star Vacuum" type, to supply 1,500 h. p. It is approximately 49 inches square by 8 feet high, and is furnished with an oil separator and water softening and purifying medium. There is a 6-inch connection to the feed pump suctions, which branches off to a 5-inch to each pump suction.

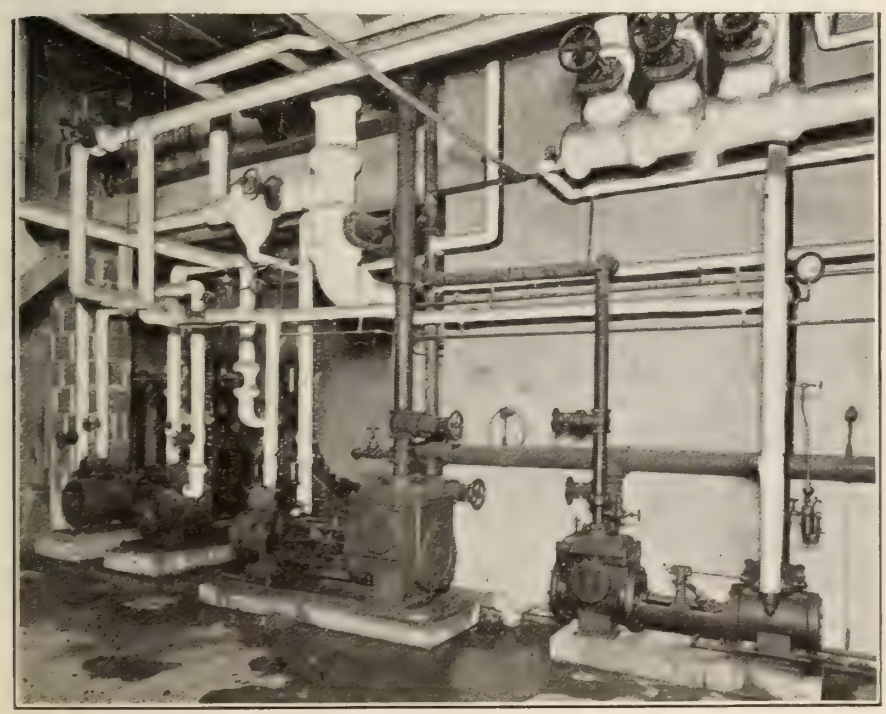
The feed pumps of which there are two, are of the outside packed type, Burnham, made by Darling Bros., Montreal. They are of the simplex type 14 inches by 9 inches by 16 inches.

There are also two vacuum pumps in this boiler room one of 10 x 14 x 16, and the other of 8 x 10 x 12. It will be noticed that these pumps are a duplicate of those in the old boiler room. It is the intention when the new plant is completely installed, to have both the large vacuum pumps in the new boiler room, but as the arrangement exists at present, each boiler room presents a completely independent unit if so required. The new boiler is fitted with a three retort standard type Jones underfeed stoker, furnished by the Underfeed Stoker Co. of Canada. There is a blower engine and fan, supplied by the Canadian Blower & Forge Co., for furnishing forced draft.

For the present coal is dumped down a chute from the street level, and fed into the stoker hopper by hand, but when the plant is complete, there will be a conveyor from the bunker to the hoppers, eliminating the hand work.



This view shows steam connection from new boiler crossing to riser and bypass.



Feed and vacuum pump. The air eliminating tank is in the corner above the feed pumps.

The pressure carried on the main steam piping (high pressure) is 125 lbs. and this is reduced where required through reducing valves to supply cookers, washers, laundry, and heating system.

The main steam header is carried over to join the present header in the engine room, and from this header are carried all the necessary connections to pumps, etc., as well as a reduced steam connection to the heating main, and a reducing bypass to the heater.

The exhaust piping and heating mains are so arranged that there is no possibility of a high pressure being developed in the low pressure lines, an atmospheric relief valve guarding against any possibility of such an occurrence.

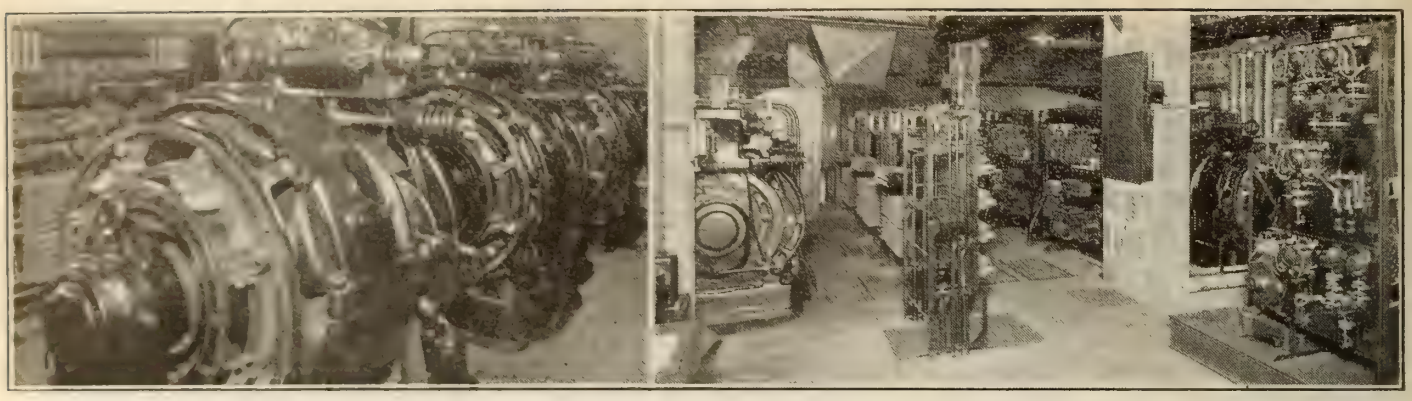
All the heating arrangements above the basement in the old building are taken care of by the main return system, but the heating apparatus on the basement level is provided with a separate line. This was found necessary some years ago before the new building was ever thought of, and considerable trouble was experienced with one section of the old building.

It was discovered that this trouble was due to what practically amounted to a water seal on the return piping, which dropped below the level of the vacuum pump, and then rose again to the pump suction, forming practically a U bend and holding up the returns from this particular point.

This bend was straightened out by the introduction of this special basement line, and the trouble was forever eliminated.

Boiler Room Drainage

Owing to the fact of the new boiler being so far below the street level, it is also below the sewer level. Provision has therefore to be made for taking



A view of the motors, and of the control gear for the six Otis Fensome Passenger Elevators.

care of the surface water which would otherwise lodge on the boiler room floor. To handle this there is fitted two No. 2 grade Duplex Yeoman's sump pump and sump.

The sump consists of a 48-inch by 48-inch by 6 feet deep brickwork well, and the pumps are two vertical centrifugal two-inch, direct connected to 240-volt direct current motors. These pumps will deliver 75 gallons a minute when discharging against a twenty foot head. They are automatically operated by floats in the sump, and a second one if the first pump cannot overcome the water. Auxiliary steam pumps for this purpose are also fitted as a standby.

Pressure on System

The heating system carries a pressure varying from atmospheric to 1 lb. per square inch on the feeding side, and the vacuum pumps maintain a vacuum of about 15 inches on the return side. This gives a total difference of pressure when the syphon traps on the radiators open of about 8 lbs. per square inch, so that there is little possibility of any holding up of the system.

It is absolutely necessary that the radiators should function without any hammering or gurgling noises and the high vacuum maintained materially assists in this result. There is an entire absence of any noises throughout the whole system, which speaks well for the general workmanship and arrangement of the installation.

Ventilating System

When the heating is taken care of there is another most important feature remaining, and that is the ample ventilation of the rooms and public assembly halls, of which there are quite a number.

This is taken care of by a number of fans, each caring for a different department. The large ballroom on the top floor requires a fan all to itself, as may be supposed, when it is remembered that there may easily be from 600 to 800 people dancing there at one time.

The fan supplying ventilation for this room is a Canadian Blower & Forge Co., No. 8 Niagara Conoidal with a capacity of 15,800 cubic feet per minute against a static head of ⅞ inch, and an outlet velocity of 1,700 feet per minute. This fan is driven from a motor by a belt drive.

There is also an exhaust fan for the ballroom with a capacity of 13,000 C. F. M. against a static head of ¾ inch, and a velocity at outlet of 1,400 cubic feet per minute. These two fans are arranged so that the direction of the air current can be diverted in the following manner. In ordinary weather, the supply fan draws in air from the louvres in the side of the building, and the exhaust fan takes the air from the room and discharges it outside.

When the weather is exceptionally cold, the dampers communicating with the outside air are closed off, and the damper between the exhaust fan duct and the supply fan duct. The air is then taken from the ballroom, passed through the air washer, with its tempering and reheating coils, and returned to the ball room at the proper temperature and humidity for the comfort of the occupants.

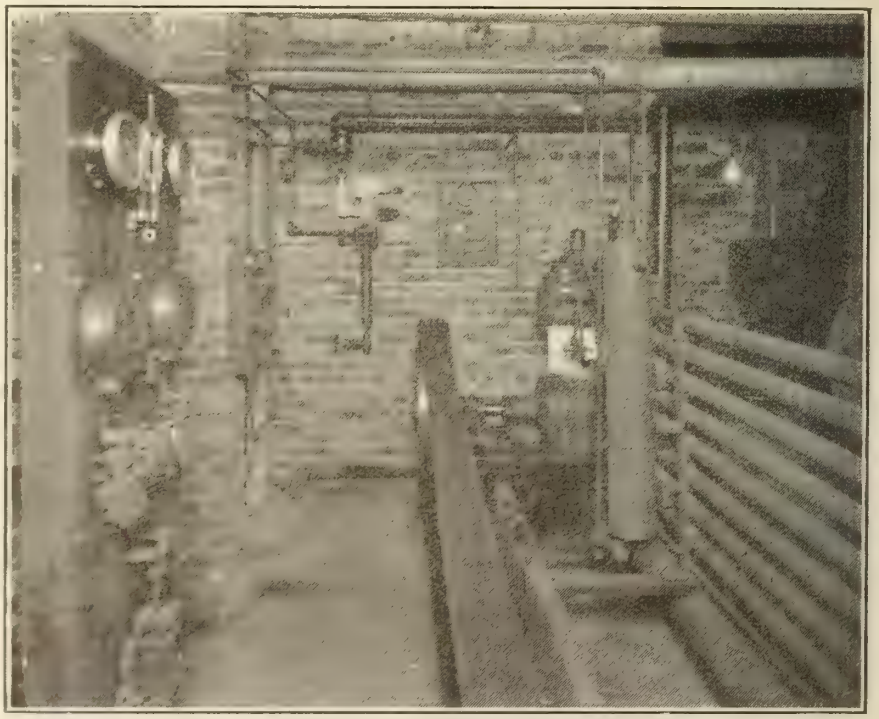
There are two fans with a combined capacity of 29,600 feet per minute for exhausting the bathrooms, and for the kitchen on the top storey there is also a fan having a capacity of 10,700 cubic feet.

There is a boiler room supply fan, with a capacity of 15,000 C. F. M., and a boiler room exhaust fan with 23,600 cubic feet capacity.

There is in addition in the engine room a Carrier air washer and fan with tempering coils for supplying air to the basement. The tempering coil and reheating coil have between them 960 square feet of heating surface, and they are guaranteed to provide absolutely pure air. This air is first relieved of all its moisture in the tempering coils, cleaned of all impurities, and then passed through the reheating coils at a definite temperature and relative humidity, which can be controlled to any desired point.

A Few Little Things

Outside of what may be considered the plant proper, there are a few little details which come under the watchful eye of the chief engineer.



York Refrigerating Machine Working Automatically for Upstairs Kitchen. Installed by the Canadian Ice Machine Co.

The engine room and maintenance crew of the King Edward. Mr. W. H. Pike, the chief engineer, is in the centre of the second row, seated.

For instance, there is a complete pneumatic system of tubes, communicating with the dining rooms, etc., and the cashier's desk, office, etc., which is operated by a fan driven by a 35 h. p, motor. A static pressure of about 2 inches water is kept on these tubes. The time required to send a message from the ground floor to the sixteenth is three seconds.

There is also a telephone system, which carries a switchboard with 1,000 stations on it, and requires 6 operators to attend to its wants. There is an ingenious system in connection with this board, for checking up messages and outside calls which have to be charged.

The operator as soon as she has finished with a call makes out a slip, which she deposits on a traveling belt running along the top of the switch board. This carries it along to a shute, down which it drops to land at the elbow of the cashier in the office. Thus no time is lost and an accurate check is kept on all messages.

This switchboard by the way is an example of the most modern equipment in existence on these lines. Among the incidentals we might include the six high-speed elevators, which do all the work of the hotel as far as the guests are concerned. There are also three freight elevators, which are out of sight of the visitor, but which are kept very busy indeed by the staff, transporting baggage, food, etc., to the upper floors. Our photograph shows the overhead work of the passenger elevation, which are the Otis, Fensome Co.'s installation. The elevator room makes a very imposing appearance. At the north end of this room is a small automatic York refrigerating machine which is solely for the use of the upstairs kitchen.

On a still higher floor are the overhead gear and motors of the freight elevators, and in this room also are contained the overhead tanks which carry the water supply which we spoke of earlier in the article.

The Engine Room Staff

To carry on all the activities of which we have given a small glimpse necessarily means a competent staff.

Mr. William Pike, the chief engineer, who has been in charge of the light, heat and power department of the hotel for the past ten years, and who has been connected with the department for the past eighteen years, is the gentleman who directs all the operations of the power department. On his shoulders has fallen all the brunt of the structural alterations, and the fitting in of this and that in such a manner that everything would go on as usual while the heart was being torn out of the building, It is Mr. Pike's pride that in all the ten years that he has been in charge, there has never been an interruption to the service, and whatever the difficulties that may turn up and have turned up, they have carried on down below without taking their troubles upstairs.

Mr. Pike's staff work mostly on the eight-hour shift principle, and no one on his staff works more than forty-eight hours per week. He has things so arranged so that he has a spare man to throw in any position should the emergency arise, recognizing the fact that one never knows the minute that these things occur. In this way there is no danger of a tie up through trying to work with an inadequate staff.

To his staff he gives no unstinted praise, and one can see that he feels a great pride in them. The details of operation he leaves to them. There is a watch engineer on every shift who is to all intents and purposes in charge of the plant while he is on duty, and this leaves Mr. Pike free to look after the broader situation which is certainly one man's job.

We have been fortunate enough, through the courtesy of the chief engineer, to obtain a photograph of the entire engine room staff, which is here reproduced, and no doubt many of our readers will recognize some old friends among them.

The group includes engineers, electricians, firemen, carpenters, bricklayers, plasterers, etc. who are employed in general maintenance work all of which comes under the jurisdiction of the chief engineer.

THE LATEST IN SCIENTIFIC VENTILATION

Very rapid strides have been made during recent years in the development of ventilation systems in Great Britain. Quite the most ingenious installation for an assembly house is that which is being arranged in the new council chamber of the London County Council. Each member is supplied with a current of pure air at the proper temperature, the speed of the current being so adjusted that no feeling of draught is experienced. The stream emerges from the desk in front of the member and drifts over his head. At his feet there is a small electric heater which can be switched on if desired. Thus the system is designed to keep the member's heads cool and their feet warm, a condition which is understood to be the exact opposite of what usually exists in representative bodies.

Another unique ventilation equipment recently installed in London is at a large film studio. The frequent occurrence of fog and the still more frequent tendency to haze in the atmosphere causes great expense and delay in the taking of film pictures in London studios. In order to ensure continuous working, an automatic system of warming and damping the atmosphere of the building was designed. All the air entering the studio is washed, filtered, and warmed; and the control is so arranged that whatever change of temperature or condition of the outside air takes place the inside air is altered in such a way that no fog is produced. The control is so delicate that even the switching on of one or two lamps in the studio meets with an immediate response by the automatic plant. An endeavor is now being made to remove from the incoming air various gases which are contained in a London fog. These gases have no effect on the photographs taken, but they cause headache and lassitude among the performers. It is claimed that this apparatus solves the problem of continuous film production in Great Britain.

Permanent Statistics In The Power Plant

This is the Second Article in the Series Dealing With Power Plant Book-keeping. The Subjects Covered Are Depreciation and Insurance Charges, Rent, Management, and Maintenance Costs

By ROBERT JUNE

FIXED charges of the power plant are made up of a number of separate items such as depreciation, interest on investment, rent and administration. Maintenance consists of renewals and repairs, and the necessary labor required to make them.

Depreciation

Depreciation results from a decrease in value of a given piece of apparatus, as a result of wear and tear, age, changing plant conditions, and changes in the art of manufacture of the particular apparatus which renders its further use inadequate. A convenient classification of the various forms of depreciation follows.

Complete Depreciation

This results from a gradual and even decrease in value, as the result of wear and tear.

Obsolescence, Inadequacy and Destruction

Marked improvements in the design of certain types of apparatus may render the use of the older type uneconomical, thus prematurely shortening its life.

Inadequacy is the result of increased demands upon capacity, which renders it necessary to discontinue the use of a given machine, or the result of changing plant conditions which render the services of a machine of a given type no longer necessary.

Destruction is the result of accident. The possibilities of accident should be covered by insurance as fully as practicable. As they cannot be anticipated, it is difficult to set up a proper reserve for them. Obsolescence and inadequacy can, at times, be anticipated, and when this is the case definite reserves should be set up to compensate for them. Whether there is reason to expect them or not, some reserves should be set up in these days of rapid developments in the mechanical arts.

Incomplete Depreciation

This is due to unusual wear and tear of the sort which is apt to fall at irregular intervals in large amounts. Depreciation may be handled by several methods, as follows:

(1) To charge to earnings in good years and credit to depreciation such amounts as the profits from operation permit.

(2) To charge to earnings the depreciation as it matures and necessitates renewals.

(3) To charge to earnings and credit to depreciation reserve annually a certain percentage of the cost determined by the average weighted life of the property.

It is quite common practice in power plant work to set up an average annual depreciation and allowance, based on the original cost of the equipment, less its value as junk or salvage, and to spread this depreciation over a period of years approximating the assumed life of the equipment. Table 1 gives the approximate useful life of the most common type of power plant equipment, based on the assumption that they are properly handled and cared for, and that maintenance and repairs are kept up. This table does not account for obsolescence or inadequacy, and its figures should be discounted on this account.

Table 1

Approximate Useful Life of Various Portions of Steam Power Plant Equipment

	Years.
Belts	8
Boilers, water-tube	25
Boilers, fire-tube	20
Buildings, brick or concrete	40
Buildings, wooden or sheet iron	15
Chimneys, self-sustaining steel	30
Chimneys, guyed sheet iron	10
Condensers, jet	25
Condensers, surface	20
Coal conveyor, bucket	15
Coal conveyor, belt	10
Engines, slow speed	25
Engines, high-speed	20
Economizers	20
Generators, direct current	20
Generators, alternating current	20
Heaters, open	25
Heaters, closed	20
Motors	20
Pumps	20
Piping, ordinary	12
Piping, first-class	20
Rotary converters	20
Soot Blowers	8
Storage batteries	15
Stokers	12
Turbines	25
Transformers	20
Wiring	15

If we consider depreciation as including maintenance, we should properly set aside as a reserve a fixed percentage for the decreasing value of the equipment to represent the unmatured depreciation. In this way we equalize matters by making the depreciation allowance larger when repairs are smallest and vice versa, depreciation smallest when repairs are largest, as the end of the useful life of the equipment approaches.

Depreciation reserves may be accumulated, therefore, either on the "straight line" or "sinking fund" method.

In the straight line method, if we assume that the total investment, less salvage, is divided by the expected life of the equipment, we will have the amount in money which should be allowed each year to cover the accrued depreciation. This is the simplest method. It is illustrated in Figure 1. Probable age of equipment may be determined from Table 1, with discounts as noted, to take care of obsolescence and inadequacy. In utilizing this method, the original cost is considered as including the net cost of labor and material, plus overhead, which includes insurance charges, fire and liability in-

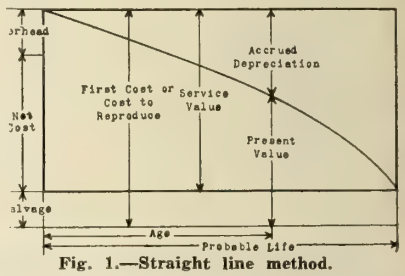


Fig. 1.—Straight line method.

surance, interest on investment during construction, installation, and, where the entire plant is being built, financial, legal and organization expenses.

Sinking Fund Method

In utilizing the sinking fund method, we set aside a fixed sum per annum, which must be allowed to accumulate at compound interest. The money thus set aside, plus accumulated interest, must be equal to the original cost of the equipment, less salvage value, at the end of the assumed life of the equipment. Again we have reference to Table 1 for the life of the equipment, and again we must make proper discount for obsolescence and inadequacy.

Figure 11 graphically illustrates a convenient method of determining the rate of depreciation in connection with

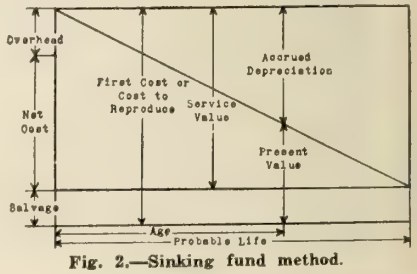


Fig. 2.—Sinking fund method.

the use of the sinking fund. Table 11 may be conveniently used in this connection.

Table II

Rate of Depreciation
Per Cent of First Cost

Assumed useful life	Rate of Interest, per cent						
Years	4	4.5	5	5.5	6	7	8
2	49.02	48.90	48.78	46.66	48.54	48.31	48.07
3	32.03	31.87	31.72	31.56	31.41	31.10	30.80
4	23.55	23.39	23.20	23.03	22.86	22.52	22.19
5	18.46	18.28	18.10	17.19	17.73	17.40	17.04
6	15.08	14.89	14.70	14.53	14.33	13.97	13.63
7	12.66	12.46	12.28	12.09	11.91	11.15	11.20
8	10.85	10.66	10.47	10.28	10.10	9.74	9.40
9	9.45	9.26	9.07	8.88	8.70	8.34	8.00
10	8.33	8.14	7.95	7.76	7.58	7.23	6.90
11	7.41	7.22	7.04	6.86	6.68	6.33	6.00
12	6.65	6.46	6.28	6.10	5.92	5.60	5.27
13	6.01	5.83	5.64	5.47	5.29	4.96	4.65
14	5.46	5.28	5.10	4.93	4.75	4.49	4.13
15	4.99	4.81	4.63	4.46	4.29	3.97	3.68
16	4.58	4.40	4.22	4.06	3.89	3.58	3.30
17	4.22	4.04	3.87	3.70	3.54	3.24	2.96
18	8.90	3.72	3.55	3.39	3.23	2.94	2.66
19	3.61	3.44	3.27	3.11	2.96	2.67	2.47
20	3.36	3.19	3.02	2.87	2.71	2.44	2.16
25	2.40	2.24	2.09	1.95	1.82	1.58	1.36
30	1.78	1.64	1.50	1.38	1.26	1.06	0.88

Interest on Investment

Interest on investment should cover not merely a percentage of the original net cost, but it should also include overhead, such as insurance, engineering fees, office charges, cost of superintendance, interest on money paid in advance of the operation of the equipment, etc., the point being to include everything which enters into the expense of putting the equipment into service.

If the equipment, or building, in the case of a complete power plant is covered by mortgage, or bond issue, the interest rate must be high enough to include the complete interest on the mortgage, or bond, as well as any differential between the total gross cost and the amount of the bond or mortgage.

If the new equipment or building is paid for out of surplus previously earned in the business, interest should be charged at the rate which the money would earn if invested in other branches of the business, or which it would earn if placed out at interest.

At this point, it is well to draw a distinction between repairs and renewals on one hand, and additions on the other. Repairs and renewals which do not increase the value or efficiency of the equipment beyond its former value must be charged to operating expenses. Additions, such as accessories which increase the value of the equipment, should be considered as capital investment. In the case of obsolescence or inadequacy, which has not been anticipated or entirely charged off in former years, only that portion of the cost of replacement above the cost of renewal of the old equipment should be charged to capital value. The remaining depreciation which has not been anticipated, must be charged to operating costs.

It should also be remembered that as depreciation occurs capital value declines, so that the amount of interest set aside each year will be less as time goes on.

Insurance

Three classes of insurance are usually required in the power plant. First, on the building; second, on equipment; and the third, liability insurance on employees. On the first two classes, the premium is in direct relation to the value of the plant and equipment. The premium on the third class bears no relation to the cost of physical equipment, being based on the cost of labor and the hazards of employment.

Description	Rate per hr.	Total hr.	Amount $	Remarks
Asst. Engrs.				
Oilers				
Firemen				
Coal Passers				
Watchmen				
Other help				
Total Gross Labor Cost (A) $				

Deductions for Maintenance to Power House Equipment

Description of Work		Name of workman	Rate per hr.	Total hr.	Amount $
Name or No. of Equip.	Kind of Work done. State Whether Repair or Renewal				
Total Deduction for Power House Maintenance (B) $					

Deductions for Construction and Repairs not for Power House

Description of work		Name of workman	Rate per hr.	Total hr.	Amount $
Location	Kind				
Total Deductions for Out of Power House Labor (C) $					
Grand total deductions for labor for non-operating purposes (B + C) $					
Net labor attendance costs A−(B + C) $					

Fig 3.—Daily report sheet for power plant labor.

Property Insurance

The relative premium on building insurance remains approximately the same year after year. However, it is extremely important to remember that when additions or alterations are made to the plant, that additional insurance should be provided. Changing replacement values of plant and equipment should also be taken into consideration. Thus, a building erected in 1912, for example, of good construction and with an estimated life of 40 years, would, in 1920, if building costs had remained the same as in 1922, be properly insured for three-fourths of its original cost. However, as building costs have approximately doubled in the past ten years, the insurance should be based on the replacement cost to-day, less depreciation, which would mean that the building should be insured at 1½ times its original cost.

Changing hazards must also be taken into account. If the fire hazard increases, the insurance companies will be found to be very prompt to cancel the policies in force and place in effect new ones at higher premiums. Should the fire hazard decrease, the owner should have the old policies cancelled and new ones issued, based on the lessened risk.

Equipment Insurance

Equipment insurance should be based on replacement value just as in the case of building insurance. If old machinery is replaced by new, the policy should be revised to take this new value into consideration in order to secure adequate protection.

Liability Insurance

Liability insurance has come to assume a very important place in power-plant costs. The premium, as a rule, is based on the pay roll, being divided however into a number of sections, each carrying a different premium depending upon the hazards of the individual class of work. As the premium may run anywhere from one to ten per cent of the actual cost of labor, it forms a very important item and should not be neglected.

The first point is to ascertain the exact amount of time put in by the various power plant employees on various classes of work, bearing different premiums. For this purpose a daily re-

port similar to that shown in Figure III is desirable. This, in addition to serving as a check on insurance premiums, may also be used for purposes of efficiency study in order to determine whether any undue proportion of time is being put in on certain classes of work.

In going into the various classes of insurance in detail, our purpose is to point out that insurance is much more of a variable than is generally supposed and that the insurance costs for a given period should not be assumed to be in definite relation to liability but that they should be ascertained exactly for the period covered by the cost analysis.

Building and equipment insurance is, of course, a fixed charge. Liability insurance is sometimes considered a part of the cost of labor and is simply added thereto as an operating expense. However, it is more simple to regard liability insurance as a fixed charge.

Rent

The value of the ground on which the power plant is built determines the amount to be charged up to rent. Where the power plant is merely one group of buildings, as in the case of a factory power plant, the rental should be in proportion to the amount of ground occupied by the power plant, coal pile, etc., as compared to the other buildings. Where the power plant stands alone, as in the case of a central station, the value of the entire real estate is based for rental charges. Here again we have to take into consideration changing real estate values. However, adjustment and rental charges need ordinarily be made not oftener than once a year.

Administration Figures

This covers such items as salaries of officers, clerical wages, office supplies, office rent, interest and depreciation on equipment, depreciation and repairs on office equipment, insurance on office equipment, postage and stationery, telephone and telegraph, legal expenses, and where power is sold as well, advertising and sales expenses. In the case of a central station, all of the above items should be charged against the cost of producing power. If the central station has other lines of activity, they must be proportioned in relation to the expenses incurred by the various departments of the business.

In the case of a factory power plant, power becomes a production expense and the overhead charged against the power plant should be in relation to the total investment, and also to the total labor expenses in the factory and the total labor expenses in the power plant.

With uniform production, administration expenses will ordinarily vary but slightly from month to month. It should be ascertained each month and figured into the cost of power. Right at this point, the writer enters the plea that the men in actual charge of the production of power be regularly supplied each month with a statement from the accounting department showing all the charges set up against the power plant for interest, depreciation, insurance, rent, administration expenses, and maintenance. These figures are all too commonly regarded as a secret. Just why this is so is not clear. The figures are usually of not the slightest value or interest to any one outside the plant nor would their possession by the operating men embarrass the management in 99 plants out of 100. Giving the operating men these figures indicates first, confidence in the integrity of the men and secondly, confidence in their ability to suggest ways and means of reducing some of these charges. Finally, it tends to curtail waste and extravagance where such exist.

Figure IV indicates a form of record which should be kept in the power plant, one sheet for each important piece of equipment. This is not a formal accounting record—its purpose is to keep the men in charge of power plant operations fully informed of the nature and extent of the investment and the various types of equipment and the cost of operating each individual unit. Its value will depend upon the individual men and their interest in their work.

Figure 1.

Fixed Charges

Type of equipment .....
Plant No. .... Building No. .....
Location ....
Manufactured by .....
Address .....
Date installed .... By whom .....
Brickwork and foundation put in by ...
Date .....
Cost of Foundation .....
Cost of Setting .....
Cost of Boiler .....
Cost of Installation .....
Total investment to date .....
Interest on investment at % annually ....
Depreciation at % annually .....
Rent based on proportionate space in bldg. occupied by each machine.
Overhead (based on proportionate share of taxes, insurance, office expenses, etc., for each machine) .....
Total annual fixed charges .....
Total original investment ....

Additions

(Do not charge wages of regular plant attendants whose time would go on anyway, against additions)
Date ....
Character .....
Material furnished by .....
Cost ....
Labor by ....
Cost .....

Maintenance

Maintenance and repair costs records should also be kept in the power plant. Again, this is not for formal accounting purposes. Its value to the operating men is to tell them where they are at with respect to the cost maintenance of various types of equipment. Maintenance, of course, refers to the expense of keeping the plant in running order over and above the cost of attendance. It does not refer to the replacement of new units but it includes the cost of keeping the plant attendants, whose time would go on anyway whether they were engaged regularly on repair work or not.

Figure V offers in convenient form a means of keeping track of the maintenance costs in the power plant. One of these sheets should be used for each machine of any size and the accounting department instructed to place at the disposal of the operating men any needed information regarding the costs which will enable them to keep those records with approximate accuracy.

Figure V

Maintenance Cost Record

Type of Equipment .....
Plant No. .... Building No. .....
Location ....
Manufactured by ....
Address ....
Name and address to call re repairs ...
Date Installed .... By whom .....
Brickwork put in by .....

Repairs

(Do not charge wages of regular plant attendants, whose time would go on anyway, against repairs.)
Date ....
Character ....
Material furnished by .....
Cost ....
Labor ....
Cost ....
Total cost repairs to date ....

In the study of the distillation of Freeport coal being made at the Pittsburgh Experiment Station of the United States Bureau of Mines, duplicate samples of the bone and cannel constituents of the Freeport seam have been distilled at low temperature in 12-pound lots. A sample of the bottom section of the clean coal was also distilled. From a comparison of the yields it would seem that the bone and cannel constituents of this seam should be of too great value to be treated as refuse.

At the Pittsburgh Experiment Station, in connection with the investigation of coal-storage problems, coal has been exposed to excess air for three hours at 150 deg. C; the amount of oxidation products formed and the amount of oxygen absorbed are taken as a measure of the tendency of the coal to ignite spontaneously. The method has been tested on Newfield (Freeport) coal and Texas lignite with fairly consistent results.

The Mueller Mfg. Co., Sarnia, expect to have extensions to their line of steam valves perfected about April 1st. This will enable them to place on the market a complete line in this department, representing a new development in their industry.

The Designing of a Triple Riveted Butt Joint

Factor of Safety Must Be Allowed—Determining Proper Thickness of Boiler Shell Plate—Strength of Boiler Shell—Sketching Proposed Joint—Resistance Against Tearing and Crushing

*By L. T. RUTLEDGE

THE STEEL to be used in the joint spoken of in the previous article in the February 5 issue, should be tested in a testing machine in order to determine its ultimate tensile, shearing and bearing values, and the value of the elastic limit for each kind of stress. The following are average values for the ultimate strength of ordinary boiler plate: in tension 60,000 lbs. per sq. inch, in bearing 90,000 lbs. per sq. inch, and in shear 45,000 lbs. per sq. inch. In boiler design a factor of safety of not less than 5 should be used; this being the usual factor employed.

Example:—It is required to design a triple riveted double strap, butt joint for a boiler 66 inches inside diameter, the maximum boiler pressure being 160 pounds per square inch. It is required that the joint be at least 85 per cent efficient.

Solution:—The first step will be the determination of the proper thickness of boiler shell plate. The boiler is a hollow cylinder, in the walls or casing of which stresses are induced by the internal pressure. The internal pressure is transmitted undiminished in all directions, and acts with equal intensity on all equal surfaces and at right angles to those surfaces. We assume that the stresses resulting from the external forces are distributed uniformly over the cross-section of the boiler shell.

Strength of Boiler

We shall consider the strength of the boiler shell in two main directions, namely, longitudinally and circumferentially. The longitudinal stress is caused by the pressure acting on the end of the cylindrical boiler, tending to tear the shell transversely. For a state of equilibrium the bursting external force must equal the internal resisting stress. The bursting force is given b the area of the cylinder end multiplied by the unit pressure, that is

$$\frac{\pi}{4} D^2 P$$

Where D is the internal diameter of the boiler, and P the internal pressure in pounds per square inch. The area that resists the bursting force is the area between two concentric circles, one D inches diameter and the other D+2t inches in diameter. This area is practically the area given by multiplying the circumference D by t. The unit stress is St. Thus the total resistance is Dts. Now as stated above, for equilibrium

$$\frac{\pi}{4} D^2 P = \pi D t S$$

$$\text{Therefore } t = \frac{PD}{4St}$$

Next, let us consider the strength of the boiler in a direction at right angles to the above. The bursting force, in this case, is that which tends to lift one half of the boiler longitudinally from the other half. The bursting force is given by the expression PDL where L is the length of the boiler inside. Although the inside surface is a semi-circle in one direction, it is quite correct to consider the resulting pressures as those at right angles to a plane through the centre of the circle; the plane being the one passing through the sections of the shell where it resists the bursting force.

The area that resists the load consists of two rectangles, each t inches in thickness and L inches long, the two sections being 180 deg. apart. The resisting area is 2 Lt. The total resistance is

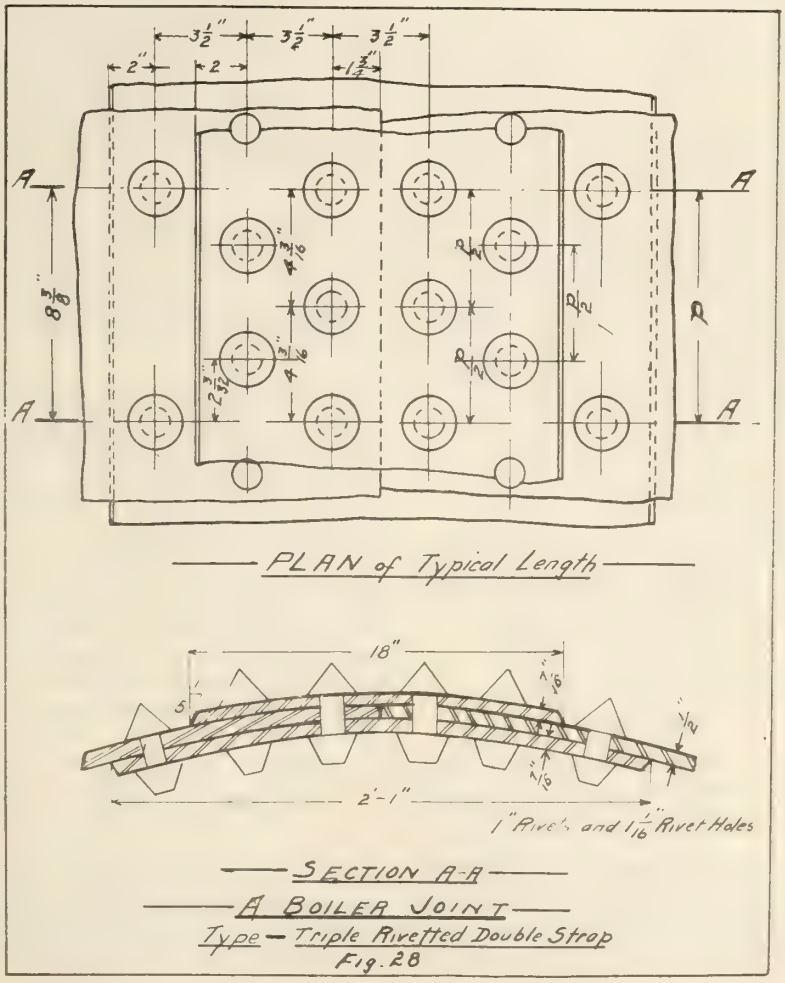
$$2Lt\,S_t$$

For equilibrium

$$PDL = 2Lt\,S_t$$

$$\text{Thus } t = \frac{PD}{2St}$$

It will be observed that this latter formula gives a thickness twice that given by the formula first obtained. This shows that if a boiler fails, it is altogether certain to fall along a longitudinal seam. So, for purposes of de-



PLAN of Typical Length

SECTION A-A

A BOILER JOINT

Type — Triple Riveted Double Strap

Fig. 28

*The author is Professor of Mechanical Engineering at Queen's University, Kingston, Ont., and should any reader wish help in any problem on mechanical matters, Mr. Rutledge will be only too pleased to offer assistance. To save time, write direct to Kingston, explaining your trouble in detail.

sign and for safety, we shall use the latter formula, which gives the greater thickness.

Then, using the data given in the problem as stated, we have

$$t = \frac{PD}{2St} = \frac{160 \times 66}{2 \times 12000} = .44 \text{ ins.}$$

We use a factor of safety of 5; hence 12,000, being one-fifth of 60,000, (the ultimate strength of the boiler plate in tension) is the working tensile strength of the joint.

The boiler joint cannot be 100 per cent efficient. We are only required to make it 85 per cent efficient. This means that the joint is 85 per cent. as strong as the solid unpunched plate. So if we use the above value of "t" and have our joint 85 per cent. as strong as the clear boiler plate, it is apparent we shall not have a factor of safety of 5 in our boiler design as the joint will lower its value. The strength of the boiler is no stronger than the joint. Now, if we wish the joint to have a factor of safety of 5, let us make the plate thicker. If we consider 0.44 inches as 85 per cent. of the thickness to be used and find what thickness would be 100 per cent. then we have fulfilled the condition as regards the factor of safety.

Therefore the thickness to be used in the design is

$$t = \frac{0.44}{.85} = .50 \text{ ins.}$$

We shall, then, specify ½ inch boiler plate, which happens to be a commercial size.

The cover-plates or straps of a triple riveted butt joint for ½ inch boiler plate will be 7/16 inch, according to tables of standard practice as given in handbooks. The diameter of rivet that would be consistent with the thickness of plates to be used is 1 inch. Thus we shall assume $t' = 7/16$ in. and $d = 1$ in.

The diameter of the rivet hole; $d' =$ 1-1/16 in. The above assumed value shall be tested in the following solution, in order to ascertain if the assumptions are correct.

In the example, the following permissible working stresses obtained from the ultimate values by adopting a factor of shaft of 5 will be assumed:—

Tension 12000 lbs. per sq. in.
Bearing 18000 lbs. per sq. in.
Shear 9000 lbs. per sq. in.

The foregoing values are good average ones for boiler steel. In most cases the values are somewhat greater.

A sketch of the proposed joint should now be made, which sketch is quite similar to the illustration in Fig. 28. There will be three rows of rivets on each side of the butt joint and it is assumed at the beginning that the cover plate on the outside of the boiler does not have to be as wide as the inner plate since the pitch of the rivets in the outer row is made twice as great as in the middle and inner row.

The results given by the various calculations for strength will indicate if this is a correct design or not. Hence if the joints fulfill the specifications there is no reason to make the butt straps of equal width. Assume "P" to be the pitch between two rivets in the outer row. A typical length of joint on which to make the calculations will be that between the two similar sections marked A—A. The adjacent lengths are exact duplicates and similar for the entire length of the boiler.

In the analysis of the joint it is best to consider and determine the resistance against every possible failure in the typical length of boiler joint.

The various resistances against failure are:—

1. Resistance against tearing of the plate in the outer row:—

Using the previous notation, we have the resistance against this failure to be

$$P_1 = (p - d')t S_t \text{ ---- (a)}$$

Where $(p\text{-}d')$ is the length of solid metal between two adjacent rivets.

2. Resistance against tearing of the plate between the rivet holes in the second row combined with the failure of the rivet in the outer row, the rivet in the outer row falling either by shear or by crushing against the cover plate:—To express this correctly we need two algebraic equations, namely,

$$P_2 = (p - 2d')t S_t + \frac{\pi d^2}{4} S_s \text{ -(b)}$$

$$P_3 = (p - 2d')t S_t + dt' S_b \text{ ---(c)}$$

In the equations just established, it is well to note the first term. In the second rivet row in our typical length of joint between sections A—A two rivet holes occur. These are shown deducted in the equations.

3. Resistance against shearing of all the rivets:—In our typical length of joint on the one side we have in the second and inner row four rivets in double shear and one in the outer row in single shear. The total of these is equivalent to nine rivets in single shear, therefore

$$P_4 = 9 \frac{\pi d^2}{4} S_s \text{ ---(d)}$$

4. Resistance against crushing of all the rivets:—The joint may fail by the crushing of the four rivets of the second and inner row against the boiler plate, and the crushing of the rivet in the outer row against the cover plate. Then the resistance against this probable failure is

$$P_5 = (4t + t')\, d\, S_b \text{ ---(e)}$$

5. Resistance against combined crushing and shearing. The joint may fail by the crushing of the four inner rivets and the shearing of the rivet in the outer row. For this we have

$$P_6 = 4dt S_b + \frac{\pi d^2}{4} S_s \text{ ---(f)}$$

A joint of this type should be designed so that it becomes stronger as the center line of the joint is approached. This condition is obtained by making equations (b) and (c) greater than (a) that is

$$(p - d') < \frac{t}{S_s} p_{II} + \frac{2}{3} t (p_2 - d)$$

$$t S_t \text{ and } (p - 2d')t S_t + dt' S_b > (p - d')t S_t$$

For simplicity in this case, where absolute accuracy is not essential, assume d' equal to d, then by simplification of the above expressions we see that the condition is obtained if

$$d > \frac{4t S_t}{\pi . S_s} \text{ --- (g)}$$

which verifies our assumption for value of d in the first place and from the second expression we find that

$$t' > \frac{t S_t}{S_b} \text{ ---(h)}$$

The algebraic solution is completed. At this point we might insert arithmetical values in equations (g) and (h). Thus d must be greater than

$$4 \times \tfrac{1}{2} \times \frac{12000}{3014 \times 9000} \text{ or } .85 \text{ inch.}$$

Therefore a one inch rivet is satisfactory.

Also t' must be greater than

$$\tfrac{1}{2} \times \frac{12{,}000}{18{,}000} \text{ or } .33 \text{ inch.}$$

Therefore a 7/16 inch cover plate satisfies the condition.

The problem is to find the value of the pitch "P." To do this, determine the

resistances of P_4, P_5 and P_6 as given by equations (d), (e) and (f)

$$P_4 = \frac{9 \times 3.14 \times 1^2}{4} \times 9000 = 63617 \text{ Lbs.}$$

$$P_5 = \left(4 \times \frac{1}{2} + \frac{7}{16}\right) 1 \times 18000 = 43875 \text{ Lbs}$$

$$P_6 = \left(4 \times 1 \times \frac{1}{2} \times 18000\right) + \frac{3.14 \times 1^2}{4} \times 9000$$

$$= 45088 \text{ Lbs.}$$

The minimum value is that given by P_5, namely, 43,875. Equate P_1 to this value in order to determine the quantity "P."

$$43875 = (p - d')t\,S_t \text{ or}$$

$$43875 = \left(p - 1\tfrac{1}{16}\right)\tfrac{1}{2} \times 12000$$

$$\text{therefore } p = 8.36 \text{ or } 8\tfrac{3}{8} \text{ Approx.}$$

Therefore P=8.36=8⅜ approx.

We shall use the value 8⅜ but before adopting it finally, we must determine the values for P_2 and P_3 with P=8⅜. On substitution in equations (b) and (c) we get

P_2=44,568 lbs. and P_3=45,375 lbs.

It will be observed that the resistance as given by P_4 and applied to P_1 is the minimum value, the value being 43,875 lbs.

The efficiency of our joint as designed is equal to the minimum resistance or the strength of solid plate of length equal to pitch.

$$= \frac{43{,}875}{8\tfrac{3}{8} \times \tfrac{1}{2} \times 12{,}000} = \frac{43{,}875}{50{,}250} = .876$$

Thus the efficiency is 87.6 per cent. which is a little higher than the specifications called for.

The detail of the joint may be completed as shown in Fig. 28. The position of the gauge lines should be clearly dimensioned. The long pitch is 8⅜ins., the short pitch is 4-3/16 ins. The back pitch should be about 70 per cent. of the short pitch. This is given as 3½ ins. For boiler work, the marginal distance should be 2 ins. where 1-inch rivets are used.

Suggested Problems

1. Determine the pressure that may be safely carried in an air receiver 60in. in diameter, the shell of which is ⅜in. thick. The longitudinal seam is of the triple-riveted butt joint type having two 5/16 in. cover plates. The rivets are ¾in. in diameter and the pitch in the outer row is 6½in. The back pitch is 2-7/16in. and the margin is 1-7/32 in. The permissible working stresses for tension, shearing and bearing are 12,000, 8,800 and 19,000 lbs. per sq. in. respectively.

2. A pressure tank 48in. in diameter is subjected to an internal pressure of 150 lbs. per sq. in. Design a double riveted lap joint for the longitudinal seam of the above tank assuming the same working stresses as given in problem 1.

REFRACTORY CEMENTS

By W. S. Quigley

The title I have chosen for this brief paper is purposely selected to bring out a point with reference to high temperature cements on which there is some misapprehension. A refractory cement is not itself just a refractory but bears its title from the fact that it is used as a binder for refractories. There is probably not a commodity used to-day by manufacturers in general that is as little understood or as much overrated as are high temperature cements.

In foundry circles there has been a great deal of educational work during the past two or three years on the use of refractory cements, and while their successful application is well understood by many foundrymen there remains much information yet to be uncovered on the whole subject of their many and varied uses. This use sprung up rapidly during the war owing to the necessity for using material having refractories which, by increasing the life of linings, would prevent shutdowns and by the use of which repairs to furnaces could be quickly made.

Four Classes of Bonding Materials

Bonding materials may be divided into four classes.

First we have fire clay, the primary function of which is to compensate for the inequalities of the bricks or shapes as a pliable refractory filler, and with which unduly thick joints generally are made. It has no binding strength of itself unless subjected to a vitrifying temperature. For the material itself there is no definite recognized standard or specification so that the user is dealing with a varying commodity. Furthermore, since heat is required for vitrification in order to obtain a bond, it is obvious that only a surface bond is obtained, as the required heat for vitrification will not penetrate the entire thickness of the wall. The result obtained may be likened to a vitrified shell with a weak structural backing. Furthermore, the shrinking of the fire clay due to its own moisture and the combined water used in mixing it, causes a separation between the bricks or shapes in walls or arches which frequently results in bulging walls or collapse of the whole structure.

Secondly we have coarse grades of mixed materials or so-called cements which also have no binding quality, depending upon heat or vitrification for a bond. Materials of this class must be made to bind or fuse at approximately the same temperature at which the furnaces are run, or no bond is effected. In other words, a cement which is good for a low temperature annealing furnace is not good for a high temperature forging furnace, or vice versa. Such mixtures are subject to the same surface bonding result as fire clay.

Thirdly, some cements in order to hold the component parts together depend upon a fibrous structure which shrinks and eventually loses its binding value as soon as subjected to any considerable degree of heat. Such cements must lose their effectiveness as the temperature increases.

An Ideal Cement

Finally, to be universal in its application, a cement should air set and not depend upon heat for creating the bond in order to form a union throughout the structure. It must be passed through a very fine mesh sieve so as to contain coarse particles which would tend to create voids between the brick which it is used to bind. It should not shrink when subjected to heat. It should be a material which can be used as a binder with crushed fire brick, old crucibles, fire sand or fire clay, ganisters, and for making rammed-in linings, and doing repair work, hot or cold. And furthermore, its composition should be such that it can be used in neat form for making small hot patches and repairs.

The principal essential of a refractory cement is that it should have at various temperatures, the same co-efficient of expansion, as nearly as possible, as the materials with which it is used for bonding. Refractories themselves differ in expansion co-efficient, as in the case of fire-clay brick and silica brick, where the former has 0.075-inch and the latter 0.175-inch per foot at 2,200 degrees Fahr. Yet a cement with a co-efficient which lies between these two could be advantageously used with both refractories.

The difference in the cost between fire clay and high temperature cements must be justified by the difference in the results obtained.

TORONTO NO. 1 LODGE

Members of No. 1 Lodge are requested to forward their due cards to the secretary, Mr. R. Edwards, 47 Afton Avenue, at their earliest convenience, for the purpose of the auditors.

CANADIAN STOKERS SOLD IN THE U. S.

It is interesting to note that a Canadian firm, the Canadian Stoker Co., Galt, Ont., have been successful in selling their stoker equipment to the Standard Underground Cable Co. of Perth Amboy, New Jersey, for a battery of sixteen boilers. Four of these stokers have been installed, and the remaining twelve will be proceeded with shortly.

Member of the Audit Bureau of Circulation

POWER HOUSE

TORONTO FEBRUARY 20th.

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

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Should The Law Be Changed?

THE CORRESPONDENCE that has been carried on in the columns of Power House relative to the advisability of making the engineer's certificate a Federal instead of a Provincial document, has about run its course. The consensus of opinion seems to be in favor of making the change, but, of course, it must be borne in mind that those writing on the subject form but a small proportion of the total number of engineers in the country. Against this may be held the fact that they also represent the members of the profession who think about their status, and are anxious to improve it.

To our mind, there is no question of the advantage to the engineer in being possessed of a qualification from an authority that would hold good all over this broad Dominion. As it is under present conditions, an engineer who might wish to remove to some other province, if he is a man with a family, must hesitate a long time when he considers that the move may necessitate him starting at the bottom again, after, perhaps, many years spent in working up. Conditions may be such in his private life that he has no alternative but to make the move. The climate of one part of the country may be unsuitable to him or his family, or the prospects of advancement may be so small in the part he lives in that it may be advisable to seek a broader field. In this latter case, he is automatically handicapped by the fact that his previous experience and his present qualification may not count for anything in his new environment.

The question of recognizing qualifications from outside of Canada seems to exercise the thoughts of a good many correspondents, and the one that is in most of their thoughts is that of the British Board of Trade. It is not our intention to go into the merits or demerits of this particular certificate, but we might point out what is the attitude of the British Board of Trade itself to members of other parts of the Empire and even to those who are not British subjects. As long as these men have the necessary experience, the same as is demanded from candidates who are natives of the British Isles, they are allowed to sit for the examination without any discrimination. It is a notorious fact that before the war there were hundreds of aliens sailing in British ships holding British certificates granted upon examination by the British authorities.

The Britishers who were displaced by these men, grumbled against the shipowners who would employ foreigners in preference to their own countrymen, but we never heard them suggesting that they should not be allowed to sit for examination.

The Dominion Government could put any safeguards it felt to be necessary on the examinations, but we do not think that the majority of Canadians would wish to exclude their fellow Britishers from other parts of the Empire from the privilege of sitting for examination.

The adoption of a Dominion certificate law would mean that a candidate's examination papers would be passed on by a central authority in Ottawa who would not know even the name of the candidate. All he would see would be the paper written by the candidate, which would be numbered by the examiner in the town in which the candidate sat, and forwarded to Ottawa for judgment. In this way there would be a standard examination, and everyone would get the same chance. It does not mean that every examination paper would be the same, but the subjects would all be based on a common standard.

The condition which now exists, where every province has its own laws and its own standards, no two of which are alike, is unfair to the engineers themselves and to the employers of engineers.

This country is large in extent but small in population. Cutting off the provinces from each other by artificial barriers will not help it any. If engineers could circulate from coast to coast with freedom, they would not only be widening their own knowledge, but the knowledge of those with whom they come in contact.

A Dominion wide certificate would raise the standard of the stationary engineer all over the country, and attract many bright young men to the pursuit of stationary engineering who see no prospects in it under conditions that practically restrict them to the province they happen to be born in.

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The Operators' Point of View

CO_2 AND TEMPERATURE

The Editor, "Power House"

I have taken up the subject of Mr. McLaren's articles on exit gas temperatures and excess air with Mr. F. A. Combe, M.E.I.C., consulting combustion and ventilation engineer of Montreal, and he says:—

"I cannot see where there is any confliction or disagreement between the theories mentioned by Mr. Pratt and Mr. Fisher regarding the influence of excess air on exit gas temperature." With this I fully agree.

Mr. Pratt gives one explanation, as that commonly accepted, that the excess air absorbs heat more readily than the boiler surface but he also states in the same paragraph that—"the other factor leading to such a result is dependent upon heat transfer rates, difference in temperature between the gases and the absorbing surface, the percentage of total heat absorbed through radiation and the percentage of total absorption through convection." Mr. Fisher dwells on these latter theories but there is no question of disagreement, — probably each factor has an influence.

In either case if the effect is the same, tests taken can be said to prove any theory put forward.

Mr. McLaren stated that some authorities hold that excess air lowers exit gas temperatures. It will do so, of course, if the air dilution or leakage is sufficiently excessive, but, within the range of average efficient operation, the temperature will increase with lower C. O.$_2$ Tests which I have taken show some similar results to those given in the article.

The formula given in Mr. McLaren's article for excess air is approximately correct only for burning of carbon, or anthracite and will not give true results for bituminous coal, owing chiefly to the influence of the hydrogen and moisture content. Thus referring to the two tests taken from Mr. Fisher's article, the excess air is 76 per cent. and 119 per cent. whereas the formula

$$\frac{20.7 - CO_2 \times 100}{CO_2}$$

would give 99 per cent. and 113 per cent. which is quite different.

The general method of determining the excess air from a gas analysis is to take the Nitrogen percentage as 100—(CO_2 + CO + O) and use the formula

$$\frac{N}{N - 3.782\ (O + \tfrac{1}{2}CO)}$$

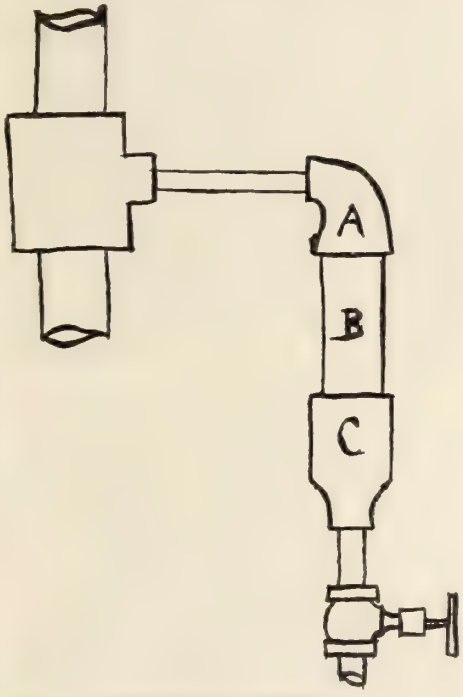
This formula gives the ratio of air actually used to that required for perfect combustion, and the excess air will therefore be 1 minus this ratio.

Mr. McLaren's formula should read 20.9 instead of 20.7 and is 175 per cent. 57.1 per cent., 49.3 per cent. for readings A. B. C. excess air.

HENRY WRIGHT.

A LUBRICATOR CONDENSER

Some lubricators are supplied without condensers, the idea being that a long pipe will be used. Sometimes it happens that there is no head room for a long pipe. Some engineers claim that a lubricator so installed will not give



Lubricator Condenser

the desired regularity of feed immediately after filling, that a short, large diameter condenser will.

By using a reducing elbow and a reducing coupling and a nipple, A B C as shown, a very good condenser is made.

DOMINION WIDE CERTIFICATE

Editor, Power House

It is with great interest I read the many interesting letters written to your valuable magazine re Dominion-wide Certificate. I am also pleased to see that the majority of the engineers are in favor of the same, which I sincerely believe would work out very satisfactorily.

I have worked as operating or construction engineer for the past twenty-three years having made several trips to the Pacific coast which has given me a pretty thorough knowledge of working conditions through Canada.

Regarding Mr. Goepel's objection to the certificate on account of the logging industry I don't think there are many stationary engineers that would care to handle a logging donkey. Therefore, I say leave them in a class of their own and continue to issue the certificate covering that particular work.

There is no doubt in my mind that the average engineer in Ontario to whom is given a certificate to operate a steam crane, shovel or mine hoist, would be capable of handling any logging donkey I have seen; and I am quite able to testify that some of them were built to make a heavy pull breaking a 1⅛ inch steel cable on test.

In conclusion, I would say, I have found conditions through Canada for the stationary engineer much the same, except the heating end of the game. I have installed plants on the Pacific Coast which did not require any installation for heat, but not so in Northern Ontario or some of the other colder provinces.

A. E. GEORGE

Amherstburg.

Editor, Power House:—

With reference to the above subject on which you invite opinions, would like to make a few comments. There is no question of it being a good thing, but to make a Dominion certificate a success there is one important condition that must be fulfilled. That is, that the highest standard of qualifications at present in use in any of the provinces should be taken as the standard for the new Federal certificate. In other words, no province should have to reduce its standard to comply with a Dominion Act. For two reasons this would not be right, viz., it would be detrimental to the craft as a whole, and it would not be fair to those engineers who have qualified and passed exams under just and strict provincial acts.

We, in the west here, think we have the best acts in Canada, while there are those in the east who think the same of their own; and a discussion of the

different provincial qualifications should result in a better understanding of what is required in an act of this scope.

Notwithstanding the opinion of your correspondent, J. W. C., to the contrary, in Power House, Jan. 5th, (who by the way does not say which province he is coaching in), there are some parts of Canada that have engineers' qualifications that compare most favorably with the British B. O. T. requirements for marine engineers, both as to shop time and operating experience. In the following comments the writer is not trying to put over a slam at the B. O. T. regulations; as used by the B. C. Examination Board, with the marine stuff cut out, they are strictly alright. But, when an engineer like J. W. C., who happens to hold a B. O. T. certificate, makes such sweeping assertions re Canadian certificates, it is up to some Canadian to fill up the gaps in his education along these lines.

He says he might have half a dozen of our certificates if he cared to house them. Is he referring to firsts or fourths? If he will come out west and try the B. C. and Alberta first class exams., he may possibly reduce the half dozen to four. He also says, "here in Canada anybody can go and sit for papers and get away with it." Evidently he does not know the qualifications for first class engineers in these most western provinces; and also, he has forgotten that he, himself, failed to "get away with it" judging by his experience where he was refused a certain Canadian certificate, or even the chance to try the examination, although he was the holder of a B. O. T. certificate.

According to J. W. C. "things are done differently in the old country." Yes, they certainly are. They are done so differently that it is not necessary for the engineer of a steam plant to have a certificate at all. This does not apply to marine work, of course. Perhaps this will explain his statement that old country ads. for engineers usually state a preference for marine engineers; or in other words, those who have taken an examination are preferred to those who have not. No longer ago than the Jan. 20th issue of Power House we have an example of how "things are done differently in the old country," where there is an account of an accident due to ignorance in draining a steam line. It is summed up as follows by the B. O. T. Surveyor-in-Chief: "The conditions obtaining at the time of the explosion clearly point to the action of water-hammer as the cause; and it would appear that *those in charge of the plant were not apparently aware* that the clearing of water of condensation from a range of steam pipes whilst in open communication with the boiler is a most dangerous practice."

If J. W. C. does not think Canadian certificates are worth the paper they are printed on, he should use reasonable caution in coaching pupils for these worthless scraps of paper. Also, he should not overlook steam turbine information, as even in the second exams. of Alberta there are questions on this important part of engineering, although he has never seen any in the exams. of the province in which he lives.

The writer has had considerable experience during the last fifteen years with both B. O. T. and Canadian engineers, and there are good and bad in both classes. Each has something to learn in taking up the other's work.

Again in the Jan. 5th Power House, Mr. Livingston compares the certificates of B. C. and Sask., and appears to have very little use for the former. His statements require a little supplementary information. The big trouble seems to have been the hiring of some returned soldiers with temporary certificates in B.C.

In the first place, the plant referred to is a T. B. sanitorium, and this may explain why a man with a temporary certificate was "hired at a salary considerably higher than the average paid in the province at the time." There are lots of people besides licensed engineers that would not care to work around an institution of this kind.

In the second place, a B. C. "temporary" is issued only upon the recommendation of the inspector in whose district the plant is situated, cannot be renewed, is good only for one year and only for the plant specified thereon. It is not reasonable to suppose that an inspector would recommend a man for one of these certificates without ascertaining to his own satisfaction that the man would be a safe one for the work required.

On the other hand, the Alberta and Saskatchewan "Provisional" certificate is good for any plant up to 50 h. p., can be renewed several times in the case of traction work, and is also issued upon the recommendation of the district inspector after an oral examination. To quote Mr. Livingston's words, re the B. C. "temporary," an engineer with this provisional certificate could work a year and then "pull out in time to escape the examination." Or he might feel like having it renewed.

Mr. Livingston also states that there is "not enough writing and too much verbal" work in the B. C. exams. as compared with Saskatchewan. If he ever sits for either a second or a first in B. C., he will likely change his mind regarding this; three days "writing" and one day "verbal" ought to satisfy him.

Another point in the B. C. Act that Mr. Livingston would have changed is the elimination of the third and fourth class certificates. Well, this is a change anyway from the engineer in the east, who some time ago advocated "scrapping" the B. C. firsts and seconds, as "they were too hard to get." The writer has heard the B. C. license law called everything from "too strict" to "the Robbers' Corporation," but this is the first time he has ever heard of an objection to the lower grades.

If the thirds and fourths were cut out as Mr. Livingston advocates, employers would have to pay more and hire engineers that would be real scarce for small plants. Also, the engineer that could not take the second or the first exam. would have no chance to run a small plant himself, and thus get more practical experience, but would have to depend on a "stand-in" with some chief for a job. This vision of Mr. Livingston's would also mean that in the absence of the engineer-in-charge, the plant could be under the care of a man that, as far as the law was concerned, might have served his apprenticeship selling lace and silk stockings to "chickens." As long as the chief of the plant thought him a good engineer, he would be alright.

In conclusion, Mr. Editor, it is the writer's opinion that neither J. W. C., Mr. Livingston, or any fair-minded person can pick many holes in the B. C. Act or its administration. It is the daddy of them all in Canada. The exams. and qualifications are equal to the British B. O. T. standard, and in framing a Dominion Act, the B. C. and Alberta ones would be good ones to shoot at.

J. A. C.

Editor's Note

There does not seem to be any need for prolonging this discussion further. The consensus of opinion of those writing on the subject is that a Dominion-wide certificate would be a good thing for the majority.

We regret being unable to publish the letters received from two correspondents this week, but would point out to those gentlemen that their letters really had no bearing on the advisability or otherwise of the Dominion certificate. If the majority of the engineers feel that there should be a federal instead of provincial certificate, then it is up to them to move in the usual constitutional manner to obtain it. If they are satisfied as things are, there is no more to be said. There would need to be a pretty efficient organization to bring about any change and it would be a long fight against the susceptibilities of the provincial authorities.

The waterworks commission of Brantford, Ontario, plan for an addition to their pumping station including installation of three gauge centrifugal pumps with electric motors.

At the February meeting of the Toronto Association of Purchasing Agents an interesting talk on "How to Buy Coal" was given by the guest of the evening, E. C. Hanson The subject was received with great interest, in view of the threatened coal strike on April 1st. The annual election of officers of the association will take place at the March meeting.

To complete the plans for the successful manufacture of Saskatchewan lignite on a commercial basis, Hon. Charles Dunning stated that it would require an additional $250,000 to carry out the work. About $800,000 has been expended to date. It is expected that the required money will be granted jointly by the Federal Government and that of the Provinces of Manitoba and Saskatchewan.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

SQUARING CRANK SHAFT

Question:—Please explain how to set a crank shaft square with the cylinder of a gas engine die of cylinder 17 in. x 25 in. stroke. Double web crank, horizontal type. There is a fly-wheel on the shaft about 9 tons with outer bearing.

I may say the centre bearing has been welded at a crack and has been reduced in diameter, so bearing has to be rebabbitted.

Answer:—Remove the piston and connecting rod from the engine, and stretch a line through the cylinder exactly in the centre, carrying it over to an upright or some fixed point just beyond the throw of the crank. In order to get the line right in the centre of the cylinder place a straightedge across the mouth of the cylinder and fasten the string exactly in the centre as found by careful measurement. In the head of the cylinder where the rod comes through place a piece of wood on which is nailed a small piece of tin, and mark on this tin the exact centre of the hole, this spot just enough for your string to pass through. Fasten the end of the string to the upright at the crank end, using a spirit level to make sure that it is straight from where it leaves the cylinder. This is the exact centre line of your engine. Now turn the crank round until the crank pin just touches the string, and calliper on each side of the string to see if it comes directly in the centre of the crank pin. Then turn the crank round on to the other centre and again measure the crank pin each side of the string. If the string lies exactly in the centre of the pin on each centre your crank is square. If not, the crank shaft must be adjusted in the bearings until it shows true.

A PIPE SCALING PROBLEM

Question:—We have a peculiar case in the plant I am in of a pipe scaling up on a steam line. There is a 12-inch header which carries two tees, one of them leading through a valve to a four inch line which supplies steam to the feed and vacuum pump. This four-inch line is taken off the top of the header, the outlet of the T looking upward, and there is a valve, then an elbow, and the four-inch runs from the elbow horizontally, being tapped for the feed and vacuum pumps. The four-inch has a little dip after leaving the elbow, but only a slight amount.

This pipe has on two successive occasions choked up to such on extent that it will not supply the pumps, not with soft scale but with scale of such tenacity that it has to be chipped out of the pipe with a hammer and chisel. I would like to have your opinion of the cause of this scaling, and why it should appear in that spot. We have Wickes boilers, and the steam is pretty dry, pressure being 125 lbs. per sq. inch. There is not much scale in the boilers, or any other place outside. My opinion was that the header was so much larger than is required to supply the pumps that there is very little circulation of steam through the four-inch header, and whatever scale-forming elements there are in the steam attacks the ell at this point.

Are there any scale forming elements left in water that has once been steam?

Answer:—This is a peculiar case, but we would be inclined to the opinion that the scale formation is more likely to be the result of oxidation caused by the settling of very hot water in this particular spot. There may also be some small particles of scale carried from different parts of the line which also settle down in this spot and combine with the scale or rust formed by the condensation in this point. There should not be any solid matter in the condensate formed from steam of this temperature. We would like to hear some other opinions on this matter.

FLUE GAS ANALYSIS

Question:—What is the basis of flue gas analysis and on what principle do CO_2 machines work?

Answer:—Flue gas analysis is for the purpose of determining what proportion of the gases leaving the boiler are carbon dioxide, the proportion of carbon monoxide, and the proportion of oxygen. By this means the relative perfection of combustion, and therefore the efficiency of the furnace is arrived at.

The basis of flue gas analysis is as follows: In order that a pound of carbon shall be burnt to carbonic acid gas or CO_2, with perfect combustion it must be mixed with a proportion of oxygen, actually 2⅔ pounds. As oxygen is not procurable alone, but is contained in air, we must use enough air to burn our pound of carbon as will contain the necessary oxygen. Now as air is composed of oxygen and nitrogen, the nitrogen being about 79 parts and the oxygen 21, it follows that we must use considerably more air than oxygen, and the actual amount of air necessary to supply the required oxygen is 11.52 lbs.

Now this would be enough if it were perfectly mixed with the carbon, and we would have perfect combustion. This cannot take place in a furnace and the result is that we have to use more than the 11.52 lbs. air to supply the necessary oxygen. The closer we can keep to the theoretical amount the more efficient we will be, and it is to determine how close we are keeping that the method of gas analysis is resorted to.

When the oxygen unites with the carbon in the proportion of 2 parts of O to one of C and makes CO_2, the volume of the gas remains the same. That is, there is the same volume of CO_2 as there was of O before the mixing takes place. Now if we have 100 parts of air of which 21 are oxygen before mixing with the carbon, it follows that had we just enough air to cause perfect combustion, we would afterwards have 21 parts of CO_2 and 79 nitrogen. Thus, then, we arrive at the fact that with perfect combustion we should have in the flue gases 21 per cent. CO_2. This would however only be the case were the combustible pure carbon. This is what the flue gas analysis is based upon.

If combustion has been imperfect we shall have instead of CO_2 and nitrogen, some CO or carbon monoxide, showing there has not been enough air to support complete combustion.

If combustion has been complete but we have used a much larger quantity of air than was necessary we shall have a smaller proportion of CO_2 as compared with nitrogen, and we will find oxygen present in the gases also if we look for it.

The amount of CO_2 wil show us approximately how much excess air we have used. Suppose that the analysis shows 12 per cent. CO_2 and the highest possible with the fuel we are using is 18 per cent. Then 18—12=6 and 6 divided by 12 gives .5 which multiplied by 100 gives 50 per cent. and this is the amount of excess air.

All flue gas recording machines are built upon the properties of certain material for absorbing the gases of combustion. Thus caustic potash absorbs CO_2. If a sample of gas from the flue is drawn through the machine and measured, and then passed through a vessel containing caustic potash, the CO_2 is absorbed. If the sample is then

passed to the first measuring chamber again, there will be a difference shown which is the amount of CO_2 absorbed. This will be shown on a calibrated scale made on the instrument. The design of the various machines is of course different, and the methods of making the record, but the general principle is the same in all.

WET AND DRY THERMOMETERS

Question:—What is the action of a wet and dry thermometer and how are they read to determine the proper amount of relative humidity?

Answer:—Air contains always a certain amount of moisture in suspension. At every different temperature and pressure of air there is a definite amount of moisture that can be carried by the air. The relative humidity is the amount of moisture contained in the air compared to the possible amount it could carry. In other words you may say that the saturation point of air is 100, and the actual amount in the air at any time is the quantity compared to 100, or the percentage. The method of determining the relative humidity is by means of a wet and dry bulb thermometer. The dry bulb thermometer is the ordinary thermometer we are used to. The wet bulb is, as far as the thermometer itself is concerned, the same, but around the bulb there is a small amount of damp cloth.

The wet bulb thermometer should be in a current of air, or should be moved around in the air when a reading is being taken, so that there is a circulation around the bulb. The theory is this. The damp cloth around the bulb of the thermometer will, if the air surrounding it is not saturated, have some of the moisture evaporated by the surrounding air, and the result will be lowering the temperature of the thermometer. Now it will be plain if the air is already saturated, or at 100 per cent. humidity, it will be impossible for any of the moisture to be evaporated, and the wet and dry thermometers will read the same.

The less the difference between the two readings, the greater the amount of humidity in the air. The greater the difference the less humidity is carried in the air. As the temperature of air rises, its capacity for carrying moisture increases very rapidly, and it is this high content of moisture with the high temperature that makes things so uncomfortable for us in what we call sticky weather. When the air contains a high percentage of humidity the body cannot evaporate the perspiration from its surface and we suffer much discomfort.

The usual limits of humidity are between 50 and 75 per cent., and the closer it can be kept to the lower limit the better it is in general.

In order to obtain the relative humidity from the reading of two bulbs it is most convenient to use a table, such as the one given below.

AIR VESSEL ON SUCTION

Question:—What benefit would be derived from putting an air chamber on the suction side of a water pump? Kindly answer through the "Question Box."—J. McC.

Answer:—The air vessel on the suction side of a pump serves the same purpose as it does on the discharge side, that is, to provide a cushion, and lessen the shock from the pulsating of the pump. In case of a pump with a long suction pipe, running horizontally or even with a slight drop to the pump, the water, when set in motion, possesses a good deal of inertia. With the alternating reversal of direction of the plungers, surges of the column of water in the suction pipe are liable to be set up, and the provision of an air vessel supplies the means of taking up these surges. You may see the same thing in a very much exaggerated form in the surge tanks provided on the penstocks of hydro electric installation. If a penstock gate is closed down either partially or fully, while a turbine is running, the inertia of the moving column of water in the penstock would inevitably carry something away if some relief were not provided The surge tank, which is a large vertical tank of from 30 to 50 feet in height, provides the necessary relief by allowing the energy of the water in motion to lift a column of water in the tank, which thus acts as a safety valve.

On a small scale the air vessel, on the suction side of the pump, performs the same function.

At the Central District Station of the Bureau of Mines at Urbana, Ill., laboratory work on the distribution of sulphur forms at certain mines in the Illinois No. 6 bed has been completed. Sulphur forms have been determined in the raw coal, clean coal and refuse resulting from washing this coal on the S. S. & S. table at Dallas and on specific gravity fractions.

RELATIVE HUMIDITY, PER CENT.

Difference Between the Dry and Wet Bulbs in Degrees F.

Relative Humidity Saturation Being 100 (Barometer 30 ins.)

Dry Therm.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Deg.																								
32	89	79	69	59	49	39	30	20	11	2														
40	92	83	75	66	58	50	42	34	26	18	10	3												
50	93	87	80	74	67	61	55	49	43	38	32	27	21	16	11	5	0							
60	94	89	83	78	73	68	63	58	53	48	43	38	34	30	26	21	17	13	9	5	1			
70	95	90	86	81	77	72	68	64	59	55	51	48	44	40	36	33	29	25	22	19	15	12	9	6
80	96	91	87	83	79	75	72	68	64	61	57	54	50	47	44	41	38	35	32	29	26	23	20	18
90	96	92	88	84	81	78	74	71	68	65	61	58	55	52	49	47	44	41	39	36	34	31	29	26
100	96	92	89	85	82	79	76	73	70	67	65	62	59	56	54	51	49	46	44	41	39	37	35	33
110	97	93	90	87	84	81	78	75	73	70	67	65	62	60	57	55	52	50	48	46	44	42	40	38
120	97	94	91	88	85	82	80	77	74	72	69	67	65	62	60	58	55	53	51	49	47	45	43	41
130	97	95	92	89	87	84	82	79	77	75	73	70	68	66	64	62	60	58	56	54	53	51	49	47

BULLETINS

We have received from the B. F. Sturtevant Co., Boston, Mass., their bulletin, No. 246, describing their generator cooling apparatus. This bulletin is well illustrated and describes the details and general arrangement of the air washers and fans as applied to this particular form of ventilating. The special atomising type nozzles are clearly illustrated, and a psychrometric diagram for determining relative humidity is given.

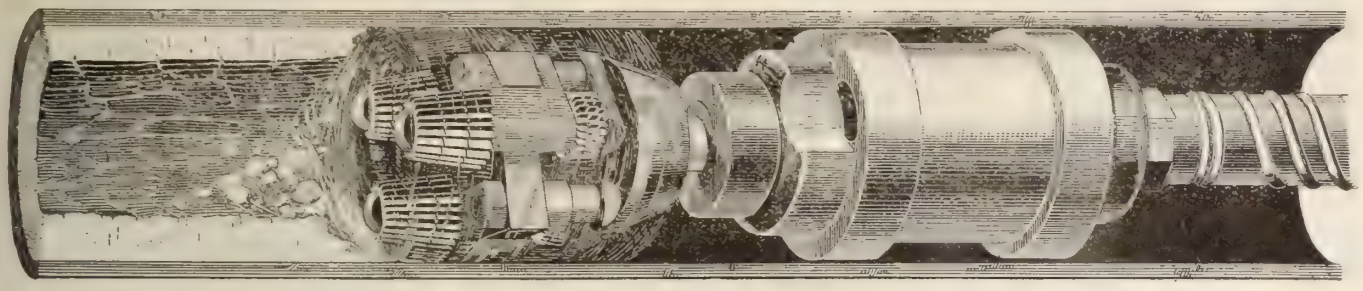
The Ingersoll Rand Co., have issued a bulletin describing their low level multijet type condenser. The booklet goes very thoroughly into the design and principle of this type of condenser, and its advantages are pointed out in a very clear manner. There are several illustrations of actual installations, as well as diagrams showing the construction of the unit.

The Canadian Ingersoll Rand Co. have issued a new bulletin describing their Price-Rathborn Oil Engine. This is a fourstroke cycle engine, vertical, with direct injection. There is thus no air compressor for fuel injection. A high economy is claimed for this engine. The bulletin contains a number of illustrations showing the construction of the engine, and typical indicator cards are included. The details of the engine are also shown, as well as some photographs of actual installations.

The Payne Dean Ltd., New York City, have issued a leaflet bulletin describing their electrical control for steam and water valves. The bulletin sets forth what the requirements for the efficient control of valves by electrical means are, and in what manner the Dean control unit fulfils these requirements. These control units are operated from any position either remote or close to.

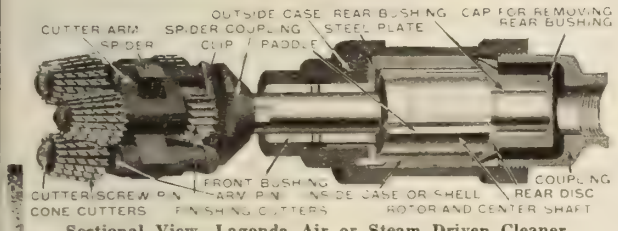
The Simplex Valve & Meter Co., Philadelphia, have issued a bulletin describing the method of making waste water surveys by means of their Simplex Pilot Tube, Portable Manometer and the Simplex Portable Chart Recorder. The waste water surveys are for the purpose of checking water leaks on water systems. It also serves to check up the slip on the pumping engine. The mode of operation is described in this bulletin. The same company have also issued a bulletin describing their Simplex boiler feed meter, which is built on the well known Venturi tube system.

We have received from the Goldie & McCulloch Co., Galt, a bulletin describing their new Type H water tube heating boiler. This boiler resembles in design to a great extent the standard cross drum type water tube boiler made by the same firm, excepting that the headers are in box form. The boiler is readily installed in even cramped quarters, as it can be shipped in knocked down form, and assembled right on the foundations in the factory or building it is going to heat.



Scale is Too Expensive a Luxury for *Your* Plant

LAGONDA TUBE CLEANERS

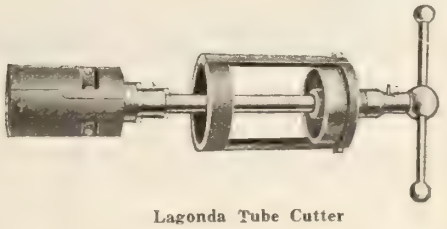


Sectional View, Lagonda Air or Steam Driven Cleaner

Lagonda Boiler Tube Cleaners are built right in every detail. They are fast, but thorough, long-lived, simple in construction. The above illustration shows a sectional view of the air or steam driven Cleaner.

Lagonda Cleaners are made to be driven by air, steam or water, and in all sizes for straight tubes or curved, in fire tube or water tube boilers. We will gladly send catalog and give full particulars.

LAGONDA TUBE CUTTERS



Lagonda Tube Cutter

Cutting boiler tubes is a simple operation when you are equipped with a Lagonda Tube Cutter. It makes a quick, clean cut, may be operated by one man and can be equipped with extension shaft for cutting tubes at any point. Descriptive bulletin and full information upon request.

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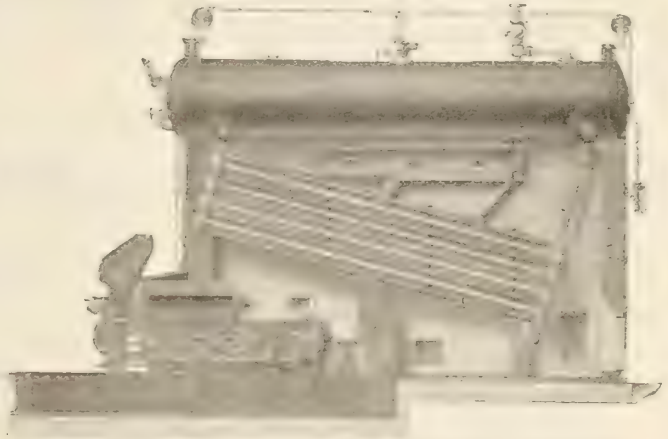

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Practical Electricity for the Power Plant

By Geo. R. Archdeacon, A. M. I. E. E.

HAVING briefly explained how Magnetism and Electricity react on each other, we will in this chapter consider the application of this phenomenon to practical things.

Every wire carrying a current of electricity develops a "magnetic field" immediately round it. If however, we form the wire into a coil and connect one end to the positive pole of a battery and the other end to the negative pole, a current will flow round the coil, this will develop magnetic lines of force within the coil.

The lines of force will extend outwards from each section of the wire in the direction shown by the short curved arrows in Fig. 1. The wire in the coil of wire being near together, all the different "magnet fields" (developed by each turn) will overlap each other, and by their action upon each other all lines of force within the coil will be turned in one direction, as shown by the long arrows in Fig. 1.

Such a coil is known as a "solenoid," and a piece of iron presented to the end of the solenoid is immediately "sucked" up inside the coil. This principle is frequently taken advantage of in the practical operation of various automatic systems of starters and regulators.

It must be apparent that such principles to be applied commercially must have certain definite mathematical limits, to permit of them being adjusted to suit special requirements, therefore it is necessary that we consider how we can readily define these limits.

Let us therefore consider several of the units we shall have to employ.

Electrical Units

The practical system of electrical units is based on the C. G. S. (Centigrade, Gramme, Second) electro-magnetic system.

The absolute or C. G. S. unit of Cursent is a current which when flowing in a conductor in the form of a circle of 1 cm radius, produces a magnet force of 2 x 3-1416 units at the centre of the circle.

When a unit current has been allowed to flow in a circuit for 1 second, a positive unit electric charge or quantity, or unit quantity of electricity, is said to have passed round the circuit, in the direction of the current flow.

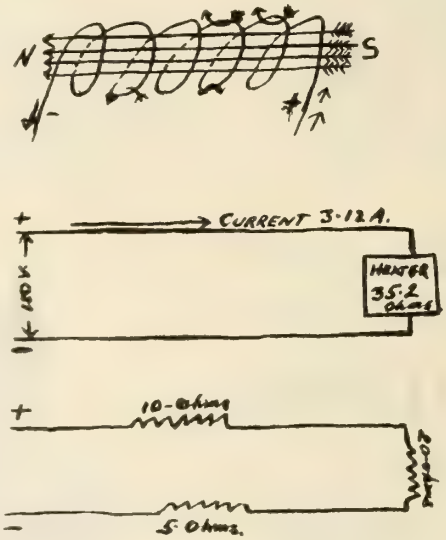
The C. G. S. system of units are not convenient for practical use, being either too small or too large; therefore the following practical system was evolved.

The practical unit of Current is the Ampere, and is equal to 1/10 of the C. G. S. unit.

The practical unit of Quantity is the Coulomb or Ampere-Second and is equal to 1/10 of the C. G. S. unit.

The practical unit of Pressure is the Volt, and is equal to 10^8 C. G. S. units.

The practical unit of Power (volt-



Figs. 1, 2 and 3.

ampere) is the Watt, equal to 10^7 C. G. S. units.

The practical unit of electrical energy is the Joule or Watt-Second and is equal to 10^7 C. G. S. units.

The practical unit of Resistance is the Ohm, and is equal to 10^9 C. G. S. units.

It will now be observed that in every circuit along which current flows, there are always Voltage, Amperage, Resistance, and surrounding the wire a magnetic field. (In an Alternating Current-Circuit several other units enter into our calculations. These will be dealt with in subsequent chapters).

Consider the voltage as exerting a pressure forcing the Ampere against the opposition of the resistance through the circuit. In overcoming this resistance work is done and heat is generated.

In overcoming the resistance and in the generation of heat many of the Volts are absorbed and lost. Hence the necessity for making a provision for the "loss of voltage" in any circuit, otherwise if it is intended to light an electric bulb the voltage or pressure may be so overcome in the struggle that there will not be enough energy left to make the bulb glow with its normal brilliancy.

Before proceeding further let us get a concrete idea of what these units of Pressure, Current, and Resistance really mean.

Practical Definitions

The Ampere (named after Ampere the French physicist) is the unvarying electric current which, when passed through a solution of Silver Nitrate of a particular strength, deposits Silver at the rate of 0.001118 Gram per second.

The Ohm (named after Ohm, a German physicist) is the electrical resistance offered by a column of Mercury, 106.3 cms. high of a cross sectional area 14,4521 Grams in mass and at the temperature of 32 deg. F.

The Volt (named after Volta, an Italian physicist) is 0.6974 of the electrical pressure between the poles of voltaic cell known as Clarks cell. Taken at a temperature of 15 deg. C.

The German physicist Ohm established the law which was named after him. and is known as Ohm's Law. This law establishes the relationship of Resistance to Pressure and Current in any Direct Current Circuit.

Ohm's Law states that:—

The strength of current is equal to the electro-motive force divided by the resistance.

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This law is expressed in a formula as follows:—

$$\text{resistance} = \frac{\text{voltage}}{\text{current}} \text{ or } R = \frac{E}{I}$$

$$\text{current} = \frac{\text{voltage}}{\text{Resistance}} \text{ or } I = \frac{E}{R}$$

voltage = current x resistance or E = I x R.

It is most important that the power house engineer should thoroughly grasp this law, and learn the formula "off by heart" as it will render all the calculations necessary for the distribution of light and power a comparatively easy matter.

With the object of exercising the application of this formula we will now apply it to several problems that will be frequently encountered in the operation of a power plant.

(Ex. 1.) To find resistance. Voltage and Current given.

An electric heater consumes 10 amps, working on a voltage of 100 volts. What is the resistance of the heater?

$$R = \frac{E}{I} = \frac{100}{10} = 10 \text{ Ohms Resistance.}$$

The heating element of an electric oven for use on a 110 Volt circuit is found to have a resistance of 35.2 ohms.

What current will it take when the current is switched on?

$$\text{Current} = \frac{\text{Voltage}}{\text{Resistance}} = \frac{110}{35.2} = 3.12$$

amperes.

How many volts are required to send a current of 25 Amps through a conductor having a resistance of 15 ohms?

Volts = Current x Resistance = 25 x 15= 375 amps.

A coil of wire 85 yards long, when connected to a 220 volt circuit permits a current of 15 amps to pass.

What is the resistance per foot length of wire?

$$\text{Resistance} = \frac{\text{Volts}}{\text{Current}} = \frac{220}{15} = 14.66$$

85 yards x 3 = 255 feet.

ohms for 85 yards.

∴ 255 feet of the above wire has a Resistance of 14.66 ohms.

What is the resistance of 1 foot?

Obviously this will be $\frac{1}{255}$ of 14.66

$$\frac{1 \times 14.66}{255} = .65 \text{ ohms.}$$

The above are just a few examples of the practical application of Ohm's Law. It is most essential that the student should make himself familiar with the practical application of this law, as by repeated practice he will gradually [illegible] an "electrical sense" so that he [illegible] almost instinctively apply this law whenever he has to employ some form of current consuming device on his plant, and for which he naturally must provide the necessary wiring, etc., and allow for the additional consumption of current.

Whenever the necessity arises for any of these electrical calculations it will be found to considerably simplify matters if a sketch of the proposed circuit is made, as by this means one can visualise just what is required and what is actually going to happen. Furthermore this practice has the advantage of familiarising the student with electrical circuits and the methods of tracing them out. (Fig. 2).

Since the advent of the small storage battery for use in starting the automobile it frequently happens that the battery needs recharging. If there is a source of direct current available it is a simple matter (and less costly than taking it to a battery station) to charge at the plant, but great care must be taken to calculate the amount of resistance necessary to only pass the required current, so that the battery is not damaged by the charging at too high a rate. The application of Ohm's Law will then become an interesting and an economic experiment.

Conductance and Resistance

Naturally all the materials used in electrical work offer resistance to the flow of current, and this resistance varies with each substance. All substances and liquids may be divided into three classes, according to the ease with which the electric current can flow through them. These classes are known as "conductors," "semi-conductors," and "non-conductors." The general name applied to a non-conductor is "insulator."

All the metals and alloys appear to be in the class of conductors, certain fluids such as dilute Sulphuric Acid, Sal-ammoniac, Salt Water, etc., are Semi-Conductors.

Rubber, glass, air, paper, ebonite, mica, etc., are insulators.

The power of conducting electricity is called conductance, whilst the power of resisting the flow of electricity is called resistance.

Conductance and resistance are therefore opposite properties, and are possessed to some degree by all substances. A substance that possesses high resistance, also possess low conductance. If therefore we know the resistance of a substance, we can easily find its conductance.

Silver appears to have the highest conductivity, whilst a special alloy of copper and nickel (used in making resistances) has the lowest.

The conductive power of metals varies with their physical condition (whether they are hard drawn or annealed). Alloys according to the percentages of certain metals composing the alloy.

Copper has a lower conductivity than silver, but on account of its comparative cheapness, ductility, and freedom from oxidation, it is generally used for the cables and wires in most electrical work.

Platinum and iron are almost equal in power of conductance, and have only 1/6 the conductivity of copper. Yet in spite of the fact that platinum is dearer than gold and has such comparative poor conductance, it is used exclusively for leading in the current through the glass of the ordinary electric bulb, and also for the contact tips of electric bells. There are however special reasons for its application. In the first case the co-efficients of expansion of glass and platinum are almost equal; the application in this case prevents any leakage of air into the electric bulb, and in the case of the contact points of the electric bell, etc., on account of its power of withstanding the burning and wearing action of electrical sparking.

Care should therefore be taken to see that an electric bell (especially if for heavy duty) possesses platinum contact tips.

The enormous difference between all insulators and conductors can only be appreciated when we compare one of the best and one of the inferior insulators with a conductor such as copper.

According to Ayrton and Mather, "Micanite has a resistivity 2,960 trillion times greater than copper, whilst slate is some 52,000 billion times greater."

The subject of insulators is a very highly technical one, and is only briefly touched upon by the author, as it is necessary that the power house engineer should keep the subject in mind, especially if circuits have to be run in damp places or where steam or chemical fumes are frequently escaping into the air. It should be also borne in mind that the greater the pressure in the circuit, the higher must be the resistance of the insulator employed.

The resistance of a wire depends upon four things:=

(1) The kind of metal or alloy.
(2) Its Length.
(3) Its cross sectional area.
(4) Its temperature.

The resistance of a given piece of wire (neglecting temperature) is directly proportional to its length, and inversely proportional to its cross sectional area.

Resistance is generally expressed in ohms, but in cases of very high resistance, such as are found in all insulating materials, it is expressed in megohms, a megohm being one million ohms. The Greek letter Ω (capital omega) is the symbol always used to represent megohms, whilst the small omega is frequently used to represent ohms. Very low resistances are expressed in microhms, this being one millionth of an ohm.

As the number of ohms resistance of any length of wire varies in an inverse

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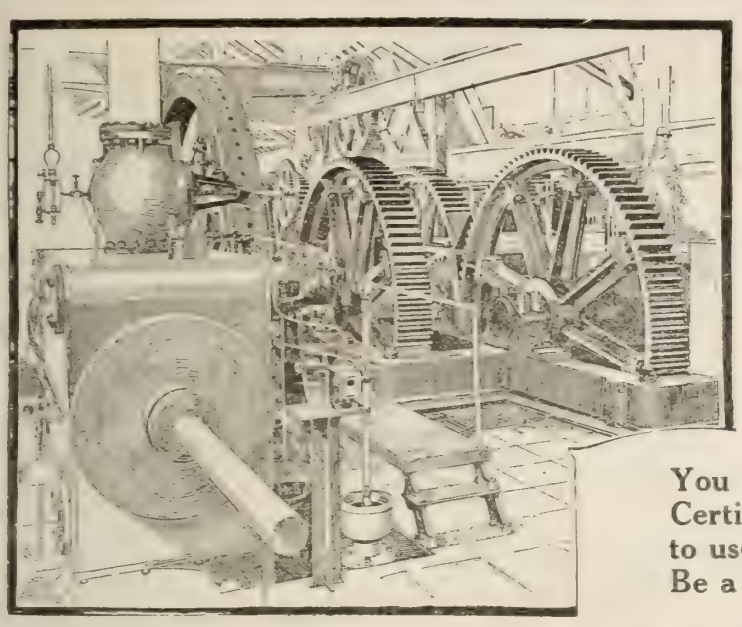

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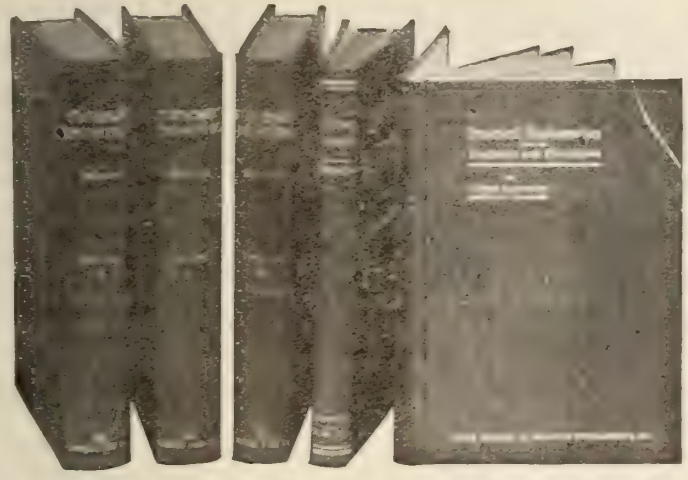

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ratio with its cross-section, it is important that this point be well understood, otherwise in choosing the size of a cable for transmission of electric power, many thousands of dollars may be lost in the power wasted in the cable.

Area and Diameter

Sectional area and diameter are not directly proportional to each other. A wire with twice the diameter of another has more than twice the sectional area, in fact it will have four times as much. If the diameter is 3 times as great the sectional area will be 9 times. In other words the sectional area is proportional to the square of the diameter. Therefore, if the diameter be doubled, the sectional area will be 4 times as great.

Example:—

To find the cross-sectional area of a conductor given its diameter, and sectional area of a conductor of different diameter.

If a wire has a cross sectional area of .00181 sq. in. what will be the area of a cross-section of a wire whose diameter is 2.5 times as great?

In this example remember that the increase of sectional area will be proportional to the square of the increase of diameter. Thus denoting the diameter of the first wire by 1, and the sectional area to be found by x we have the following proportion:

$$x : .00181 :: (2.5)^2 : 1$$

$$\frac{x}{.00181} = \frac{2.5 \times 2.5}{1}$$

$$x = .00181 \times 6.25$$

$$= .00113 \text{ sq. in.}$$

It is often necessary to find the sectional area of a wire in sq. in. This sectional area is generally termed its effective area, because it is made up of numbers of separate strands of wire, the area of each separate wire only has to be considered. These strands are formed in a circle, we cannot measure the area of each separate strand, so we take the total diameter of the complete circle of wires, square the diameter and then multiply it by .7854 and the result is the area in sq. in. Let D stand for diameter, then—

The sectional area of a wire is $.7854 \times D^2$

Frequently the diameter is expressed in mils, instead of fractions of an inch. One mil is a thousandth part of an inch. (.001) In such cases the sectional area is expressed in circular mils.

Example:—

Find sectional area of a wire whose diameter is 180 mils.

$$180 \text{ Mils} = .18 \text{ in.}$$

$$\text{Sectional area} = .7854 \times (.18)^2$$

$$= .7854 \times .0324$$

$$= .0254 \text{ sq. in.}$$

In all electrical circuits there are various forms of resistance, and it is frequently necessary to find out the total amount of resistance in a given circuit. There are only two ways in which resistances are introduced into the circuit and they are known as series and parallel.

Resistances in Series

The total amount of resistance in a circuit when connected in "series" is the sum of each separate resistance added together.

In Fig. 3 there are three resistances in series having values respectively of 10 ohms, 20 ohms, and 5 ohms. The total resistance therefore is 10+20+5=35 ohms.

Resistances in Parallel

The calculation of resistances in parallel is not quite such a simple matter, except in the case where each of the resistances is of equal value such as a number of similar electric bulbs.

If two similar-sized electric bulbs are connected in parallel the total resistance of the circuit is reduced one-half, if 3 lamps are used it is reduced one-third, etc.

Let the equal number of resistances be denoted by n, and let r be the value of the resistance of one of them, the combined resistance will be shown by the equation.

$$\text{Total Resistance} = \frac{R}{N}$$

Should each of the resistances in parallel vary in resistance, then the total resistance in the circuit is a much more complicated number to calculate.

Conferences have recently been held between representatives of the Bureau of Mines, and the Navy Department concerning the coal developments in the Bering River field of Alaska. The suitability of the coal for navy use and the possible application of the Trent process in treatment of the coal were discussed. Studies have been made regarding the application of this process to assist coal mines producing coal with much impurity in Oregon, Washington and Alaska.

The city council of Montreal, Quebec, plan waterworks improvement for the coming year to the extent of $700,000.

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- Electric Hoists

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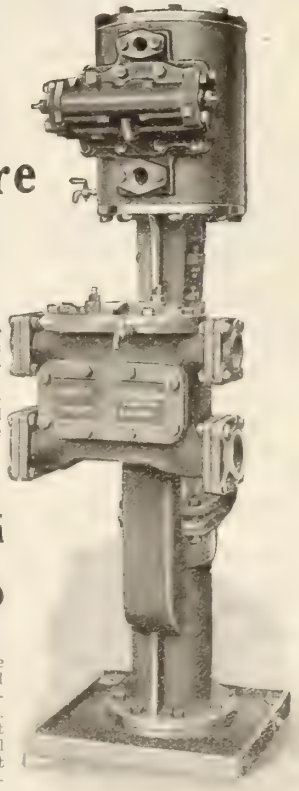

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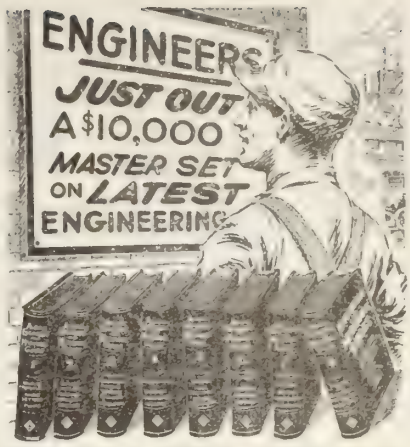

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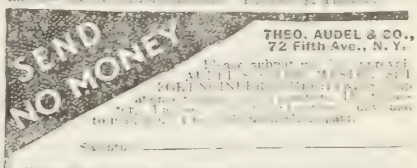

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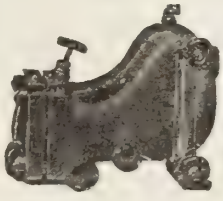

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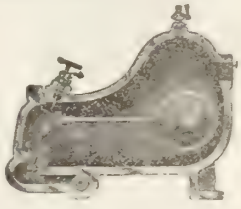

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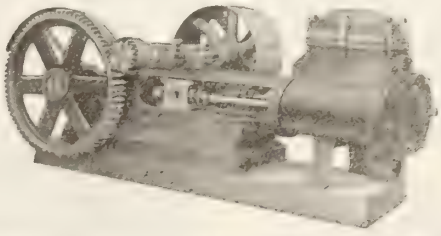

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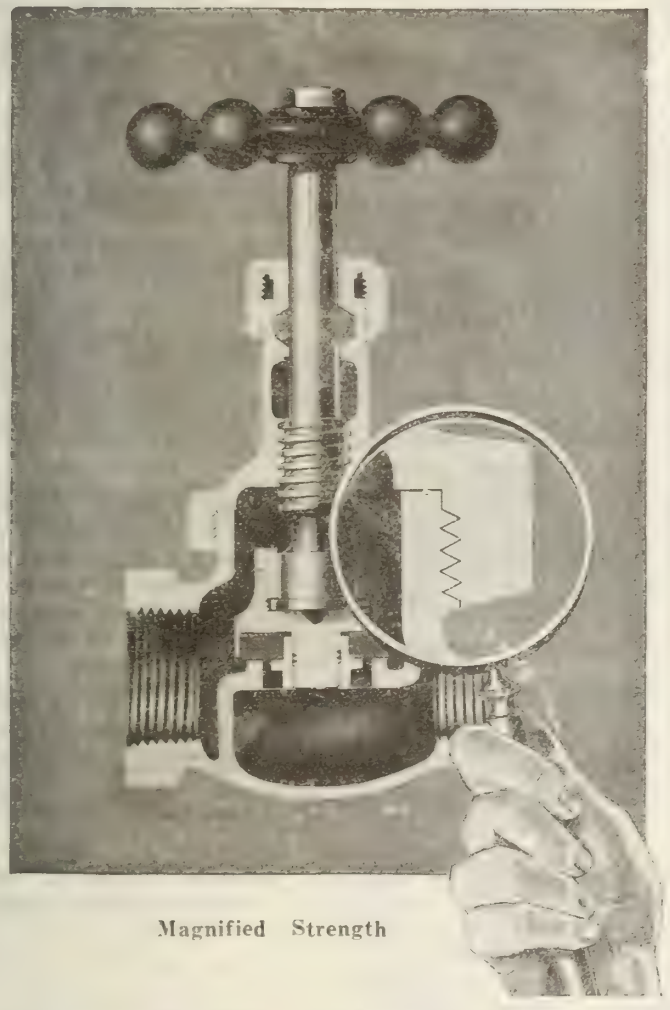

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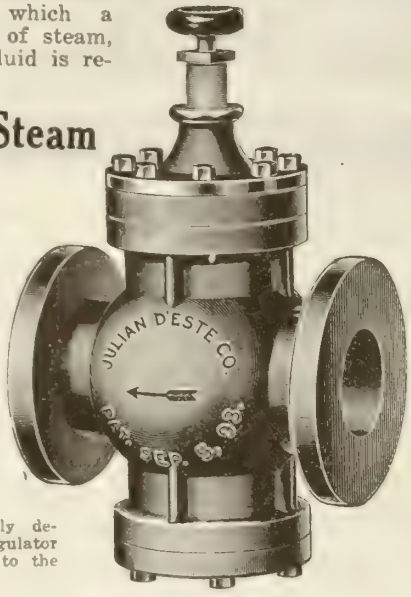

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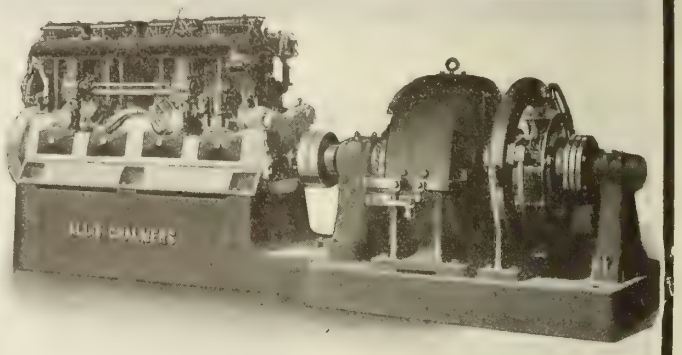

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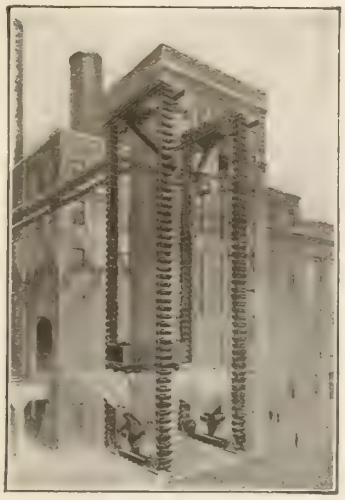

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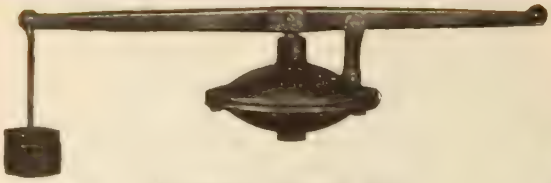

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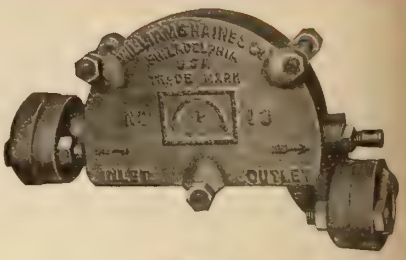

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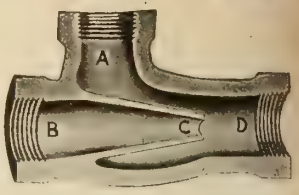

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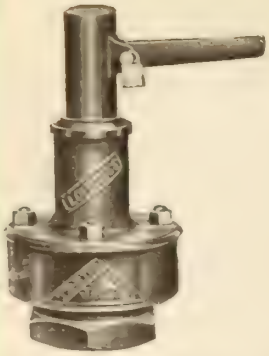

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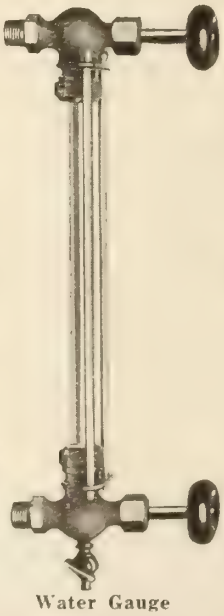
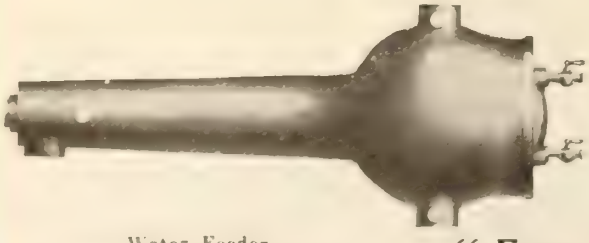


Water Gauge

Radiator Valve



Water Feeder
automatically keeps the water in the boiler at required level

Vacuum Valve

"Every Installation is a Demonstration of Merit"

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto
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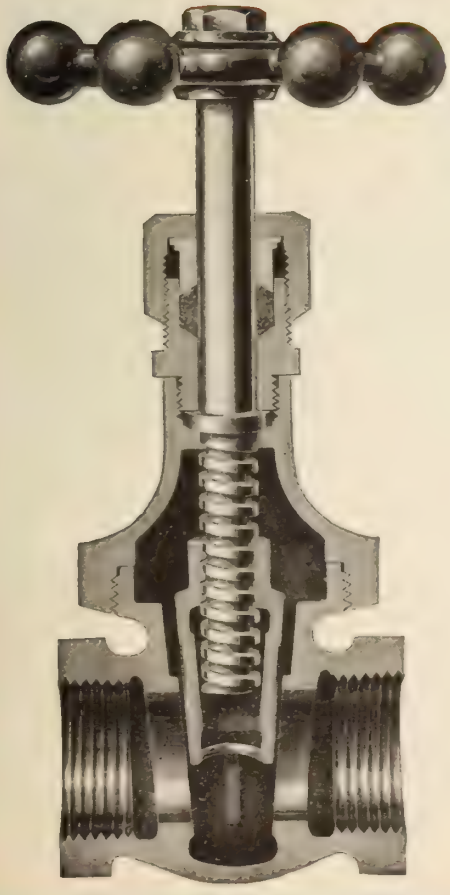
Vol. XV.—No. 5 — Publication Office, Toronto—March 5, 1922 — Published Semi-Monthly Canada, $2; U.S. $2.50 a year

PENBERTHY

BRASS GATE VALVE



EIGHT REASONS WHY
YOU'LL LIKE THIS VALVE!

1. OUTSIDE BONNET CONSTRUCTION
2. Non-Rising Spindle
3. Solid Wedge Disc
4. Packing Gland and Follower
5. Special Easy Grip Hand Wheel
6. Made of Best Quality Steam Metal
7. Workmanship & Finish Penberthy Quality
8. PRICE

PLAY SAFE—SPECIFY PENBERTHY VALVES

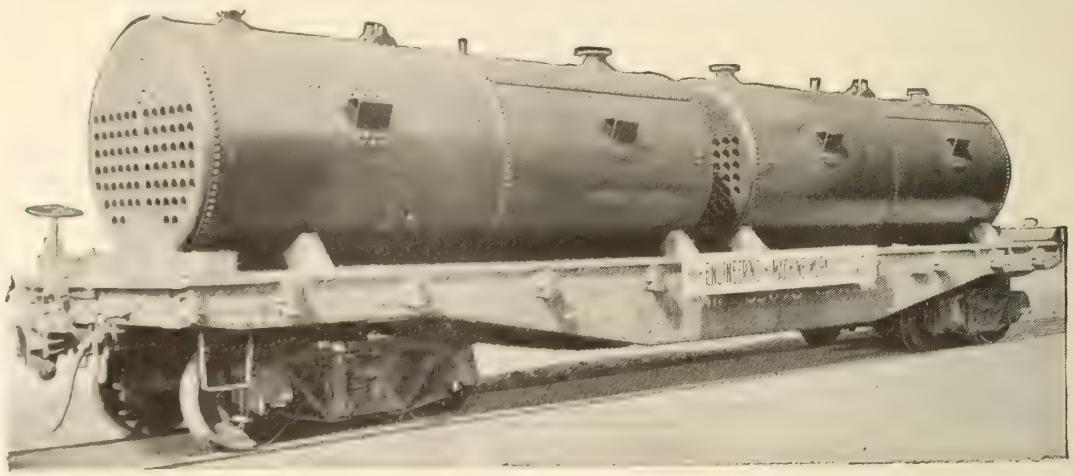
PENBERTHY INJECTOR CO.,
LIMITED
WINDSOR, ONT.

Injectors	Cellar Drainers	Grease Cups
Valves	Water Gages	Air Cocks
Ejectors	Lubricators	Priming Cups
Oil Cups	Gage Cocks	Whistles

What Are We Waiting For?.....

HERE we have a nation of people accustomed to work—with as high a consuming capacity as any in the world—with ample money resources—with new materials that are the envy of the world. What on earth are we waiting for—what more do we want to have done for us for business to be "good" again?

Let's each do one little thing now—and see the mighty change it will make—buy anything we NEED and buy it now. If your plant needs new Boilers, buy them NOW. We make all types and sizes. Our workmanship is excellent, our prices low.



Engineering & Machine Works of Canada, Limited

ST CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

Files Hand Stokers Getting Results

PANTHER RUBBER COMPANY, LIMITED

GENERAL OFFICES AND FACTORIES
SHERBROOKE, QUE.

SHERBROOKE, CANADA September 23, 1921.

The Waterous Engine Works Co. Ltd.,
Brantford, Ont.

Gentlemen:

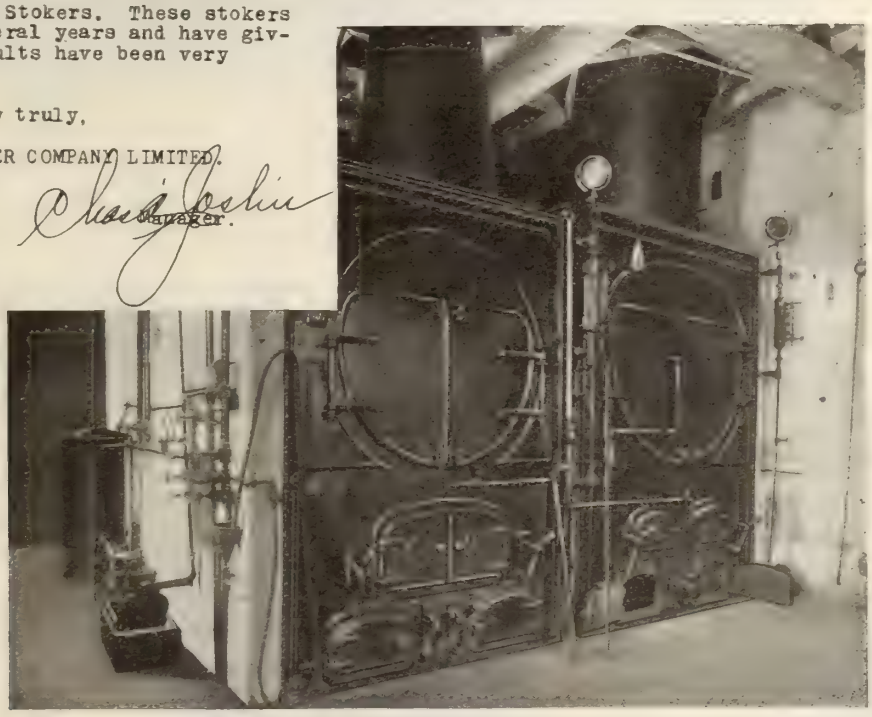
In reply to your letter of the 8th instant we have in our plant the Files Stokers. These stokers have been in operation for several years and have given excellent service. The results have been very satisfactory.

Yours very truly,

PANTHER RUBBER COMPANY LIMITED.

Manager.

CAJ/RMK



It is the uniform excellent service and general satisfaction that have caused progressive men to select **Files Stokers.** These are typical of the more complete data we have compiled:

One installation (3,600 H.P.) saved enough coal to pay for their stoker investment in five months.

A Files installation operated for five months continuously at an average rating of 223%—doubling their steam output.

Files stokers increased efficiency of one plant sufficiently high to warrant discontinuance of two out of eight boilers.

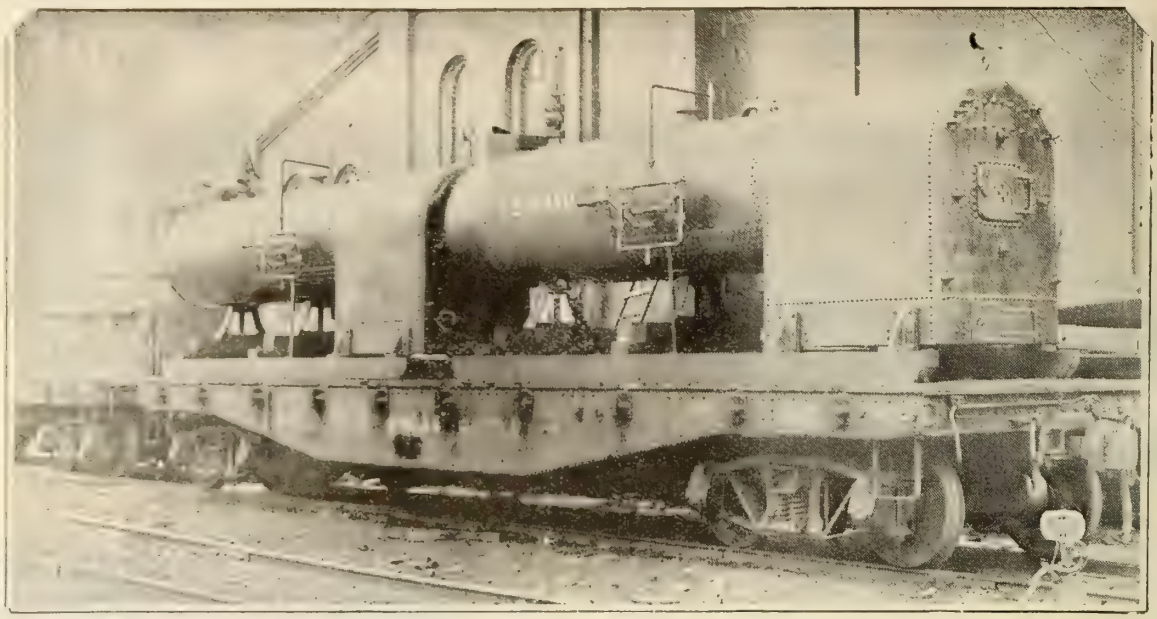
Here is a ready explanation of these achievements:—

1. **Complete volatilization of green coal, causing intensified combustion and smoke dissemination.**
2. **Correct distribution and proper proportion of air according to load carried**
3. **Fuel bed continuously kept clean, uniform and rich.**

Given the opportunity we will be glad to present these facts for your complete satisfaction.

The Waterous Engine Works Company, Ltd.

Brantford, Ontario



Two 60 H. P. Locomotive Boilers for 125 lbs. Under Ontario Regulations.

E. LEONARD & SONS, LIMITED

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Branches and Agents from Coast to Coast.

Established 1834

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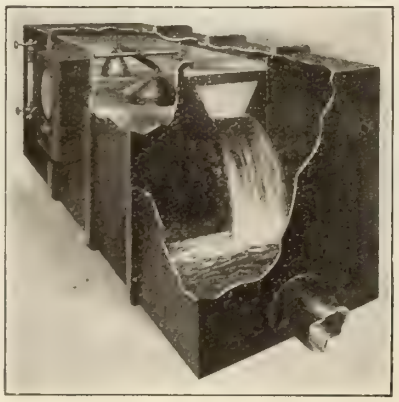
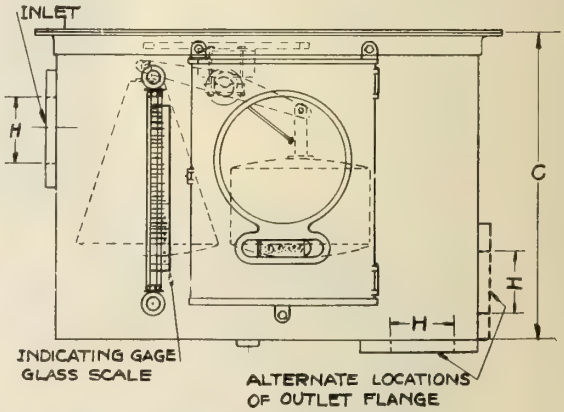
The Simplest Construction Always Proves The Most Accurate !





THE BAILEY WEIR METER

—FOR ACCURATELY MEASURING ALL LIQUIDS

Accurate and long lasting because free from troubles and inaccuracies arising from the use of cams, springs, flexible connections, racks, gears, roller guides, etc. Every plant needs it for measuring feed water, condensate, and other liquids.

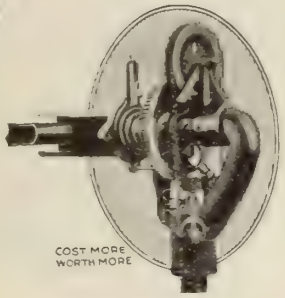
The Bailey Weir Meter indicates, records and totalizes the flow of liquids. A glance at the diagram above shows its remarkable simplicity. Can be also fitted for temperature recording. 12″ diameter uniformly graduated charts are used. Ask for bulletin No. 60.

BAILEY METER CO., LIMITED

177 Delorimier Ave., Montreal, Que.

Greater Cleanliness of Boilers Assured

DIAMOND
VALV-IN-HEAD
SOOT BLOWERS



A MARKED advantage in the use of the Diamond Valv-in-Head soot blower is the increase in effective pressure in the blower element. This is due to two factors. First—the valve offers practically a straight passage to the steam, whereas in other systems the steam must take two right angle turns through the globe valve, which causes an appreciable drop in pressure. Second—the Valv-in-Head system requires about half the quantity of pipe, valves and fittings used with other blowers, and on this account the pressure drop from source of steam to blower element is very much less.

The outstanding advantage of this increase in effective pressure is, of course, the increase in cleaning efficiency of the steam jets. With increased velocity the range of the steam jets is considerably greater and the boiler is more thoroughly cleaned in all respects.

As boilers are only effectively cleaned when the steam jets play on the tubes for a pre-determined period of time, a third and extremely important factor in insuring greater effectiveness is the use of the Valv-in-Head of reduction gearing which regulates the speed of the blower element so that all tubes are equally and thoroughly cleaned.

Greater cleanliness is only one of eleven important advantages of Diamond Valv-in-Head soot blowers. Why not let us tell you about the others?

Every boiler needs a mechanical soot blower and you will save money by buying the best. Diamond Valv-in-Head blowers are adapted to all types of water tube boilers. On request our Engineer will go over your existing soot blower installation and advise whether it can profitably be replaced with the Diamond Valv-in-Head system. Ask for your copy of Bulletin 287 describing the new soot blower.

DIAMOND SPECIALTY CO.
WINDSOR, ONT.

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

More Than Ten Years' Service

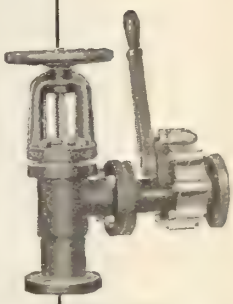
Not One Cent for Repairs

The two Yarway Seatless Blow-Off Valves shown below are in the plant of the Riverside Highland Water Co., Colton, Cal.

These valves have been in continuous service since their installation in February, 1912. One has never been repacked; the other was repacked once.

The packing used was furnished with the original order, so these two valves have not cost one cent for repairs in ten years of service. Recently, they were reported both absolutely tight.

Records like this indicate one reason why so many careful, economical operators prefer the Yarway Seatless Blow-Off Valve. The whole story is told in Booklet B-410—awaiting your request.

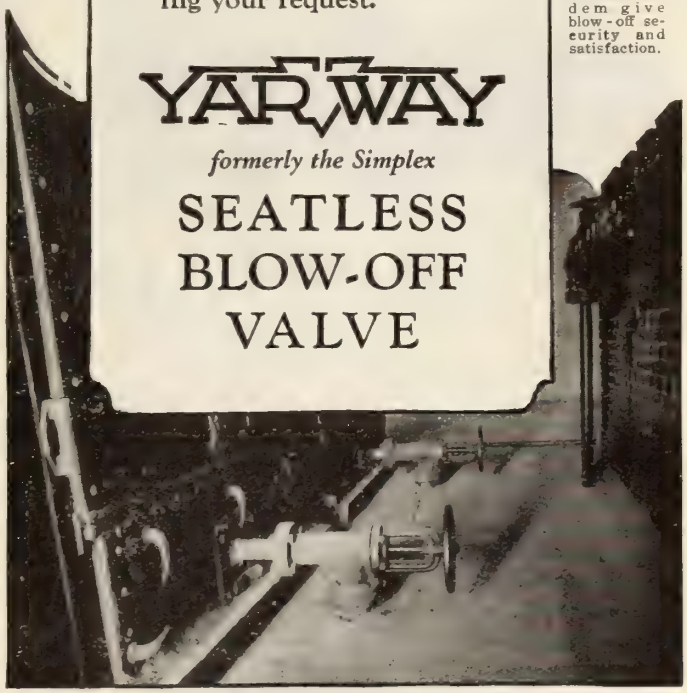


If you require two valves on the blow-off line, remember this: the Yarway Seatless and Yarway Double Tightening Valves in tandem give blow-off security and satisfaction.

YARWAY

formerly the Simplex

SEATLESS
BLOW-OFF
VALVE



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Representatives in all Principal Cities
For Complete List of Offices see Sweet's Engineering Catalog-Keystone Mining Catalog or Chemical Catalog

YARWAY SEATLESS BLOW-OFF VALVE··YARWAY DOUBLE TIGHTENING BLOW-OFF VALVE··YARWAY BOILER SKIMMER··YARWAY ADJUSTABLE SPRAY HEAD··YARWAY HYDRAULIC VALVE··YARWAY UNLOADER YARWAY-LEA V-NOTCH METER··YARWAY PIPE CLAMPS ETC.

YARWAY
POWER PLANT DEVICES

New Truths and Old Fallacies

WEARING QUALITY - Continued

The writer witnessed the remetalling, with Magnolia, of a large quarter-box engine bearing about 18" x 22". Owing to its difficult location, which occasioned considerable loss of time in removing and replacing, besides the time spent by the pattern makers' and machinists' work, it took practically ten or twelve hours to complete this job. In the meantime the mill was shut down, at heavy loss of production and a dozen or more men were engaged in this work.

Imagine using on this bearing any metal of unknown or doubtful quality for the purpose of effecting a saving in cost. It would have been unpardonable to have jeopardized such an important interest for such a trifling consideration.

By using Magnolia, engineers and mechanics are practically relieved of all censure in case of trouble with the bearings because it is the recognized standard throughout the mechanical world, and, therefore, its use implies no lack of judgment or forethought. We are fixed unalterably in our belief that it is true economy to use Magnolia on bearings of all classes however light and unimportant the service, as the saving in the long run in power, oil, wear, etc., will far exceed the difference in cost between Magnolia and cheaper grades of metals.

In a case brought to our notice, a line shafting babbitted with Magnolia "was the only thing about the factory that had withstood the ravages of time" after long service. The computation of the saving in this instance in comparison with what a cheaper metal would have cost, if such computation were possible, would be an eye-opener.

(Continued next month)

For copy of complete article:

"New Truths and Old Fallacies"

Address Our Montreal Office

Sold by leading dealers everywhere or by

MAGNOLIA METAL CO.
OF CANADA, LIMITED
Office and Factory:
MONTREAL: 37-39 SHANNON ST.

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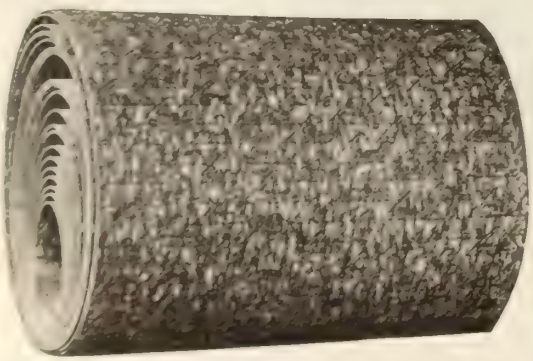
NOW MADE IN CANADA



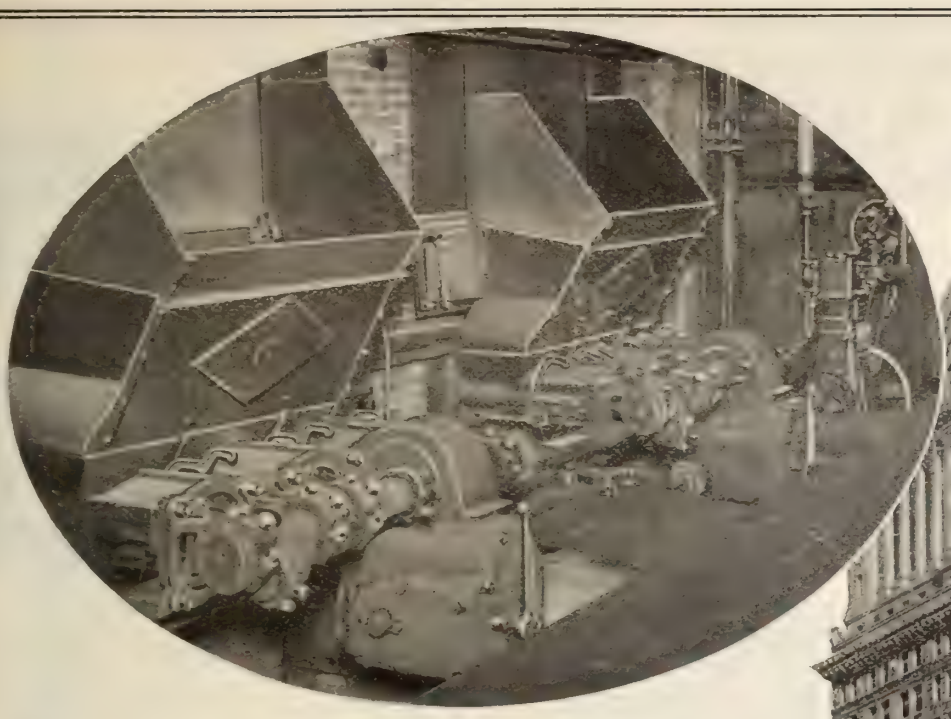
Durabla Sheet and Gaskets are now made in Canada.

Guaranteed to make a tight joint wherever a permanent gasket is required.

DURABLA MANUFACTURING CO.

Distributed by

The Canadian Fairbanks-Morse Co. Limited



Riley Stokers---Union Central Life Insurance Bldg.

CINCINNATI, OHIO

The Union Central Life Insurance Building is the tallest office building west of New York City. It towers 495 ft. above the street level and contains 8 acres of floor space.

Speaking of the

RILEY UNDERFEED STOKERS

installed here the Manager of this building states:

"The Riley stokers installed in our boiler room have been giving us complete satisfaction, and have been in almost continuous operation since their installation."

Riley Stokers are particularly adapted where elimination of smoke is a necessity. The **moving grates** keep the fuel bed even, active and porous, allowing an intimate mixture with air at all times. The hydrocarbon gases after being distilled in the retorts pass up through an active body of burning coke, then through the fire zone, passing off as invisible, completely burned gases.

Ask for our Catalog H-3, describing the Riley Underfeed Stoker in full.

The Sanford Riley Stoker Company is now prepared to equip new Riley Stokers with coal agitators licensed under the Negus-Tiffany patents.

"A type to meet every stoker need"

SANFORD RILEY STOKER CO.
WORCESTER, MASS
RILEY UNDERFEED STOKERS

TRADE MARK Rx REGISTERED

MURPHY IRON WORKS
DETROIT, MICH
MURPHY AUTOMATIC FURNACES

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND CINCINNATI CHICAGO ST. PAUL KANSAS CITY DENVER

Now is the Time for Repairs

Many a Factory and Mill can confidently look forward to an early date when their plant will be running full time. Every factory should be gone over and needed repairs to BELTING attended to now. It would be disastrous to stop at a rush time and it would be foolish to run the risk of a hold-up through neglect.

Look Over the Belting

To make sure your wheels will never stop turning through the breakdown of Belts, equip every machine with

"P. M. S" Belting

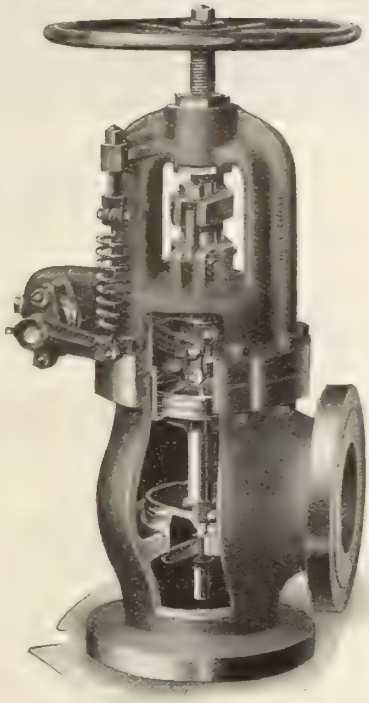
Manufactured exclusively by

Gutta Percha & Rubber, Limited

Head Offices and Factory: Toronto

LUNKENHEIMER

Safety Non-Return Valves



Iron Body, Bronze Mounted

Angle Valve, Fig. 700
Globe Valve, Fig. 374

Cast Steel

Angle Valve, Fig. 1282
Globe Valve, Fig. 1281

LUNKENHEIMER SAFETY NON-RETURN VALVES have proved their reliability in service, automatically closing and instantaneously cutting out a boiler connected in battery when the pressure within the boiler, through accident or otherwise, suddenly drops below that in the header. Their action facilitates the continued operation of the other boilers and enables the plant operatives to pursue their duties in safety.

Workmen who may have occasion to enter a dead boiler for cleaning or repairs are likewise protected, as these Valves cannot be opened by hand.

Sizes 3 to 10 inches, in Iron Body Bronze Mounted for pressures up to 250 pounds and in Cast Steel Monel Mounted for pressures up to 350 pounds and temperature to 800°F.

For Safety, Reliability and Efficiency specify LUNKENHEIMER SAFETY NON-RETURN VALVES and insist on their installation.

Distributors of LUNKENHEIMER Products situated in every commercial center.

Write for Catalog No. 58-DC.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD

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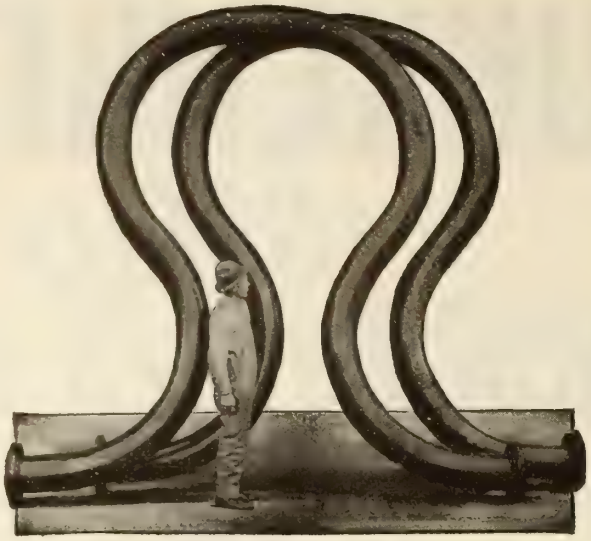
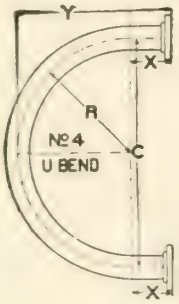
AMERICA'S BEST
LUNKENHEIMER
"QUALITY"
SINCE 1862

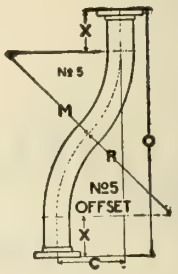


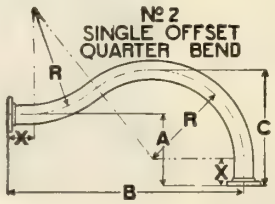
CRANE

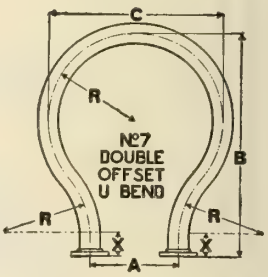
PIPE BENDS

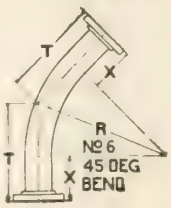
ARE THE STANDARD

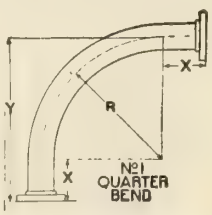












Manufacturers of Valves, Fittings and Piping Equipment and Distributors of Pipe, Plumbing and Heating Supplies.

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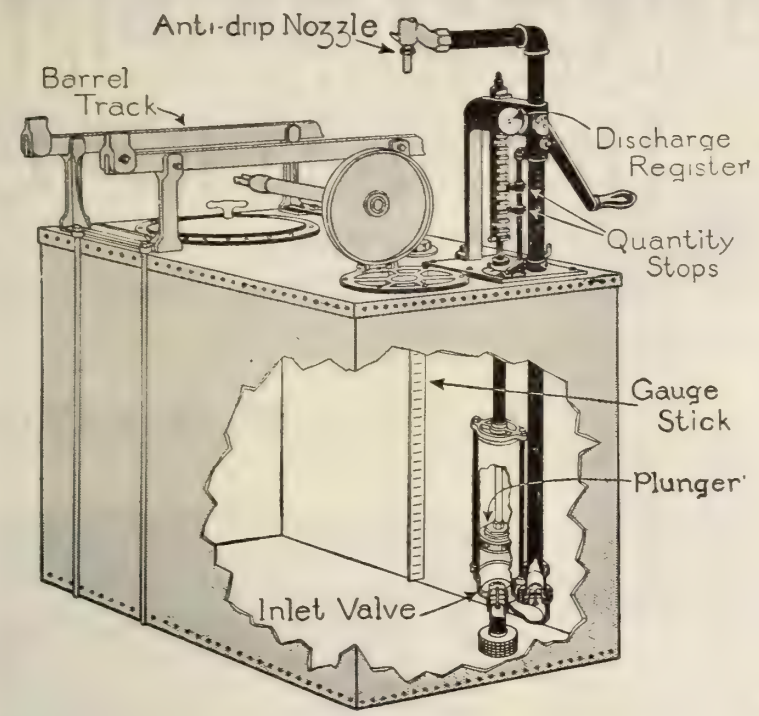
42



Mechanical Perfection Means Profit Protection

The reasons why Bowser Oil Handling Equipment stores oil economically and safely are shown in the above drawing of the Fig. 64.

The Tank, being riveted and soldered from inside, is absolutely and permanently leak proof.

The Pump is rapid in action and equipped with mechanical measuring stops. A liquid test before shipping assures accuracy.

A permanently tight tank avoids loss from leakage—it prevents contamination of oil, and keeps the oil room clean. Thus cleanliness is stimulated on the part of the employee.

The Piston-Type Measuring Pump quickly and accurately delivers any desired quantity directly into the receptacle. This prevents overflow of oilers—saves time and oil.

Write for Illustrated Booklet C-21. Bowser Equipment is MADE IN CANADA by

S. F. Bowser Co. Ltd., 2168 Fraser St., Toronto, Ont.

BOWSER
ESTABLISHED 1885
PISTON-TYPE MEASURING PUMPS

LINDE

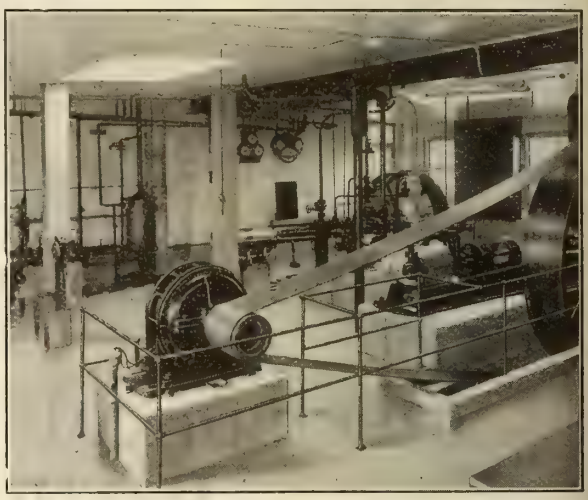
Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.

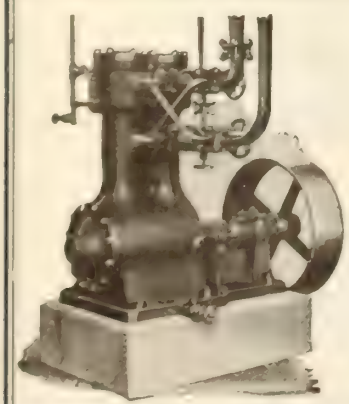


This 100-ton plant was designed by our engineers These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL,

TORONTO WINNIPEG VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

York Ice Making
and
Refrigerating Machinery

is built to operate satisfactorily under all practical conditions.

Our Vertical, Single-Acting, Two-Column, Belt-Driven Machines may be actuated by any available power. They are compact, strong, sturdy machines — scientifically designed. Built in sizes from 20 tons refrigerating capacity upwards.

Being manufacturers of all types of Ammonia and CO_2 Machines, enables us to recommend the type best suited to local conditions.

Write Our Canadian Agents

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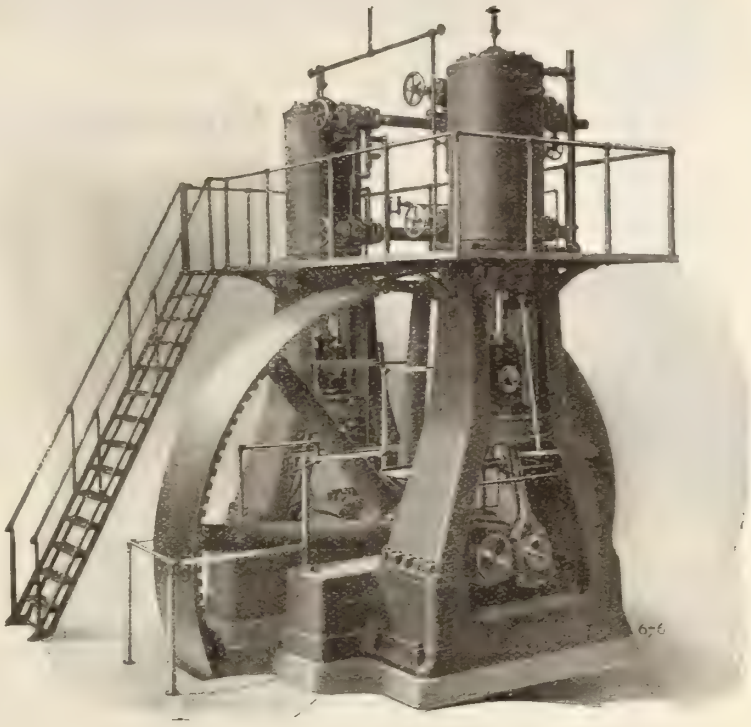
WINNIPEG .....85 Lombard St.
VANCOUVER ... .1158 Homer St.

YORK MANUFACTURING CO.
YORK, P.A., U. S. A.



JAMISON
Formerly "JONES"

Heavy Duty Cold Storage Doors

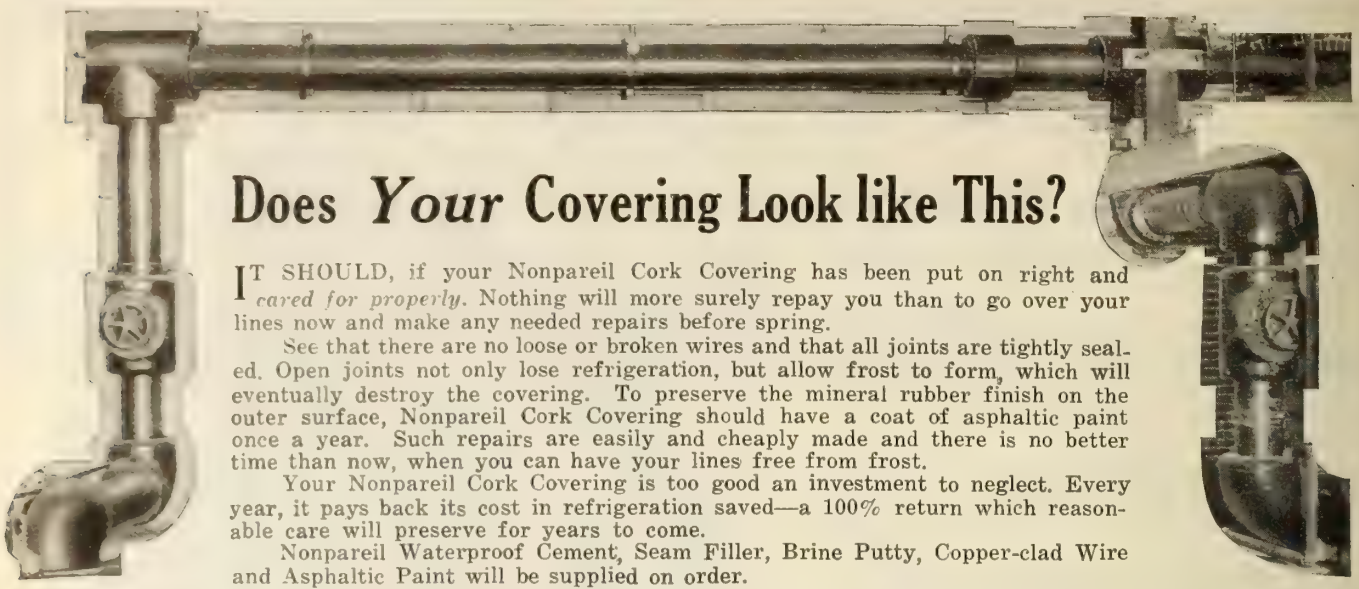
In the **Jamison** line of cold storage doors you can get a door exactly suited to your requirements. Made for all conditions and purposes.

Shown here is our Standard Bunker Door—also our Entrance and Bunker Door combined. Special attention is drawn toward the Automatic Self-tightening Fastener and Adjustable Spring Hinges. They are heavier in construction and combine practical features not found in other doors. All hardware in Jamison doors is bolted to the door and frame; no wood screws used.

These are but a few of the features that have won for **Jamison** products the reputation of the **World's Standard** by their long, unfailing performance under all conditions.

Catalogue No. 10 gives complete details—shall we send it?

JAMISON COLD STORAGE DOOR CO.
Formerly
JONES COLD STORE DOOR COMPANY
HAGERSTOWN, MD.
U.S.A.



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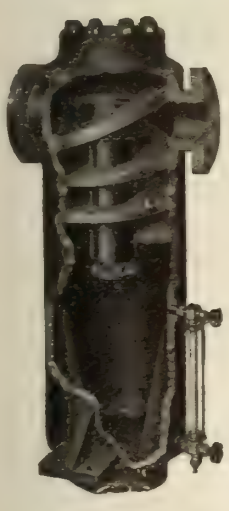

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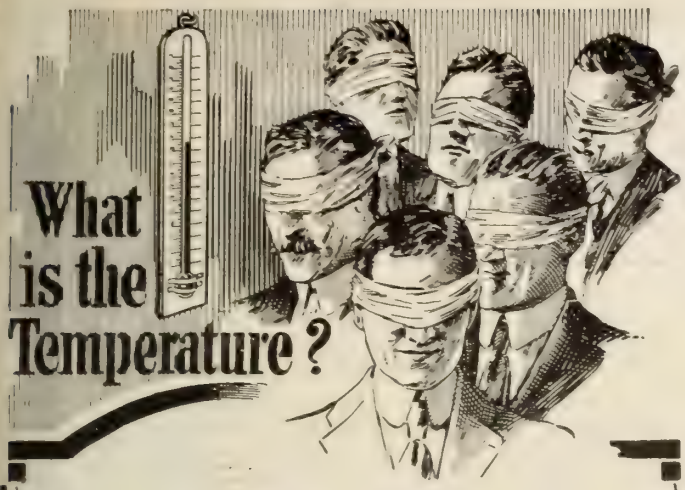

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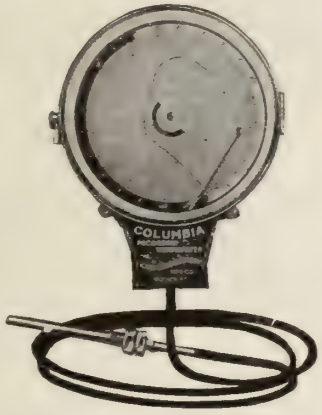

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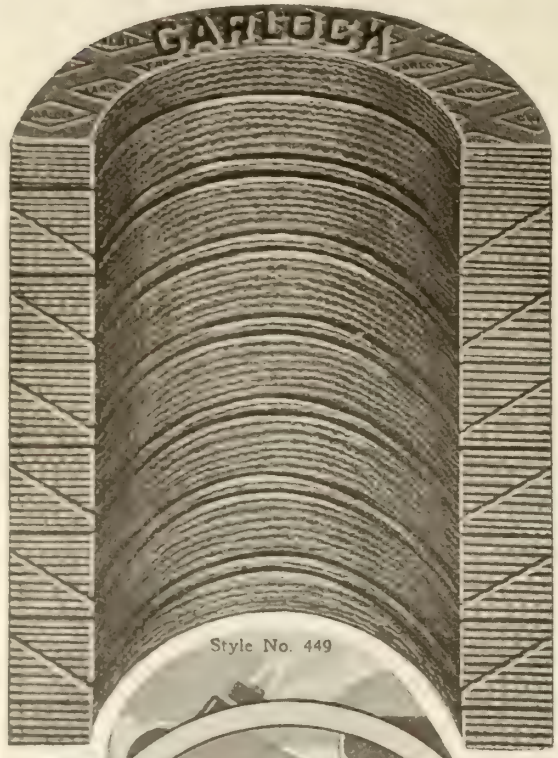

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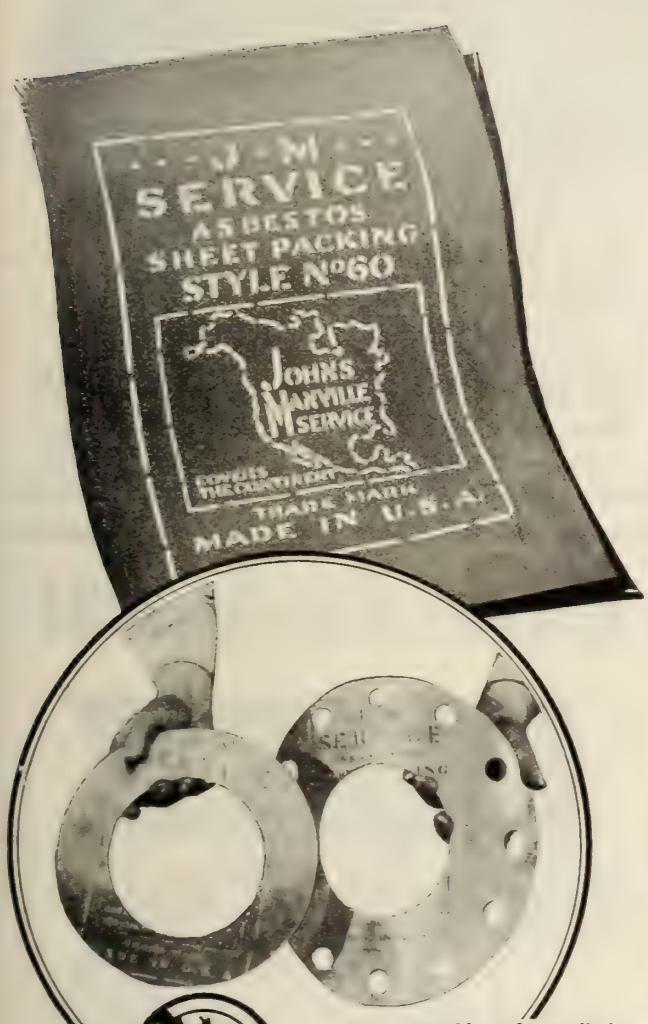

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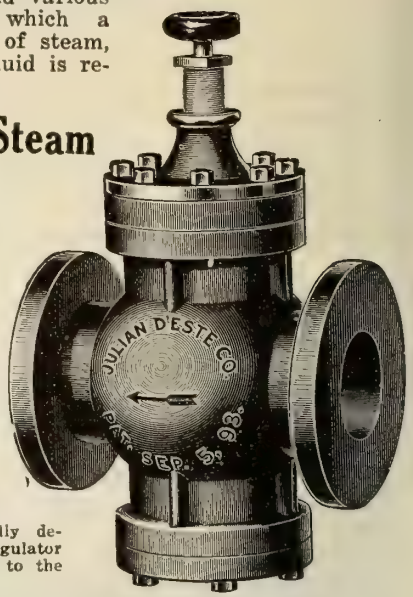

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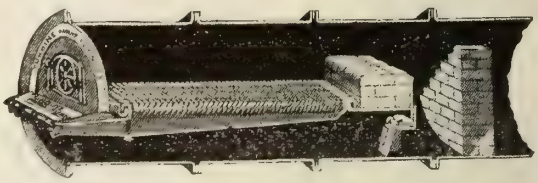

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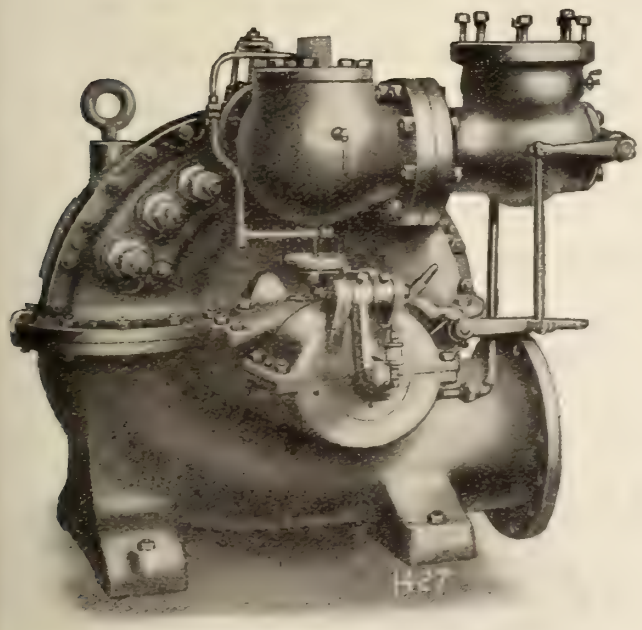

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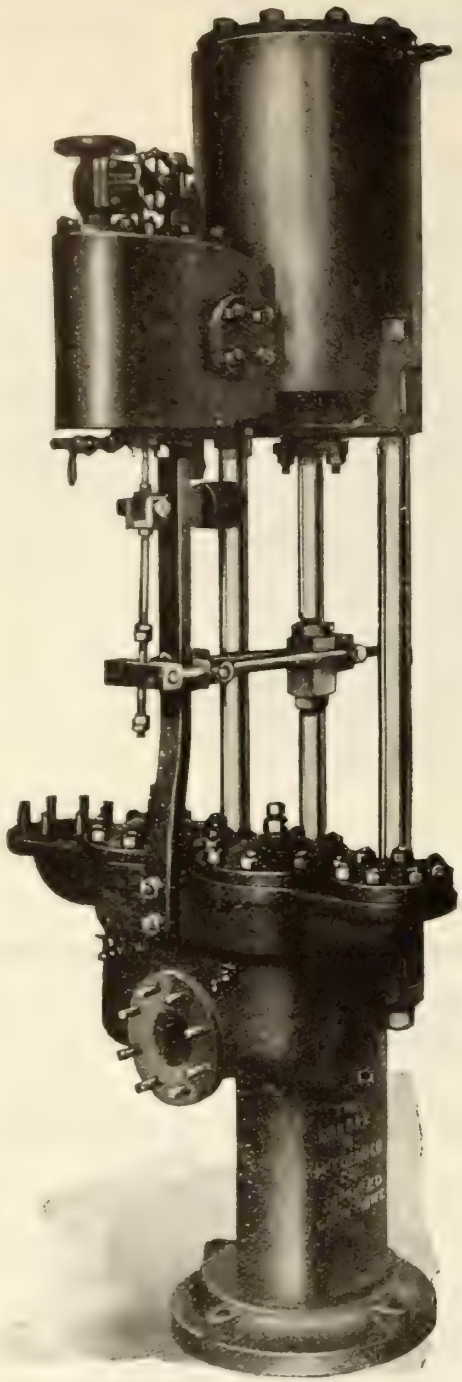

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The Power Plant Journal of Canada

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Established 1907
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A New Type of High Efficiency Condenser

How a Condenser Influences the Costs of a Power Plant. The Effects of Velocity on Corrosion a Very Important Item in The Surface Type. Points on Design

By PAUL A. BANCEL

Of the Ingersoll Rand Co., New York, before the American Society of Mechanical Engineers.

THE HEART of a power plant lies in the boiler room, and the most important aspect of the condensing plant is in its relation to boiler-room costs. The choice of a condenser may be said to rest largely on its influence in reducing boiler-room charges. As indicated in Fig. 1, it would pay to run condensing if coal cost nothing; and pay even more, if the boiler feed was poor or expensive, to install the costliest of condensers—the surface type. With pure feedwater there is less fuel loss and boiler-maintenance charges, and, what is of still greater importance, boilers may be driven at higher ratings with consequent further reductions in first costs and fixed charges.

The designer of a power house is in a quandary—flying from boiler evils to condenser evils, and often with hesitancy as to which are the less serious. The problem is one of balancing fixed and operating charges in the boiler room against similar charges in the condensing plant.

Fixed Charges

The fixed charges against a surface-condensing plant depend on—

(a) Vacuum desired, which influences the size and cost of the equipment.

(b) Cost of tube replacement, which depends on amount of tube surface in any particular design and life of the tubes as influenced by water conditions and condenser design.

(c) Power for the auxiliaries, which increases if the cost and fixed charges are reduced.

Vacuum. In Fig. 2 the curve 0-0-0 shows the absolute back pressures at the turbine exhaust which might be expected from a cycle of water temperatures and a certain investment in condenser. Frequently the design of the turbine is such and the water temperatures in the winter are so low that for certain winter periods a vacuum is obtained which is better than can be utilized by the turbine. On the other hand, the temperature of the available water supply for three to six months of the summer is 60 to 80 deg., so that the vacuums obtainable are lower than are desirable for maximum turbine economy. Area C

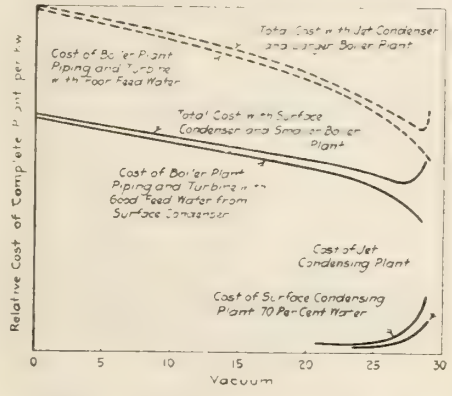

Relative Cost of Complete Plant per kw
Vacuum
0
5
10
15
20
25
30
Cost of Boiler Plant Piping and Turbine with Poor Feed Water
Total Cost with Jet Condenser and Larger Boiler Plant
Total Cost with Surface Condenser and Smaller Boiler Plant
Cost of Boiler Plant Piping and Turbine with Good Feed Water from Surface Condenser
Cost of Jet Condensing Plant
Cost of Surface Condensing Plant 70 Per-Cent Water

Fig. 1.—Relative First Cost of Steam Power Plant at different vacuums.

in Fig. 2 indicates the range of vacuums by investing more or less money.

As will be seen later, extensive calculations in regard to best investment are apt to be misleading because of the reduction in vacuum which so often occurs due to fouling of the tubes. In such instances all other questions become subordinate to that of maintaining high vacuum continuously, under actual operating conditions. In other cases the decision must rest on the relation of load factor, months of the year having hot water and the fixed charges and operating charges at different vacuums.

Cost of Tube Replacement

This can be set up as a yearly depreciation reserve. The life of a condensing plant might be 20 years, whereas the tube life might be only five. On a 10,000 k.w. turbine this might necessitate the purchase every five years of tubes costing about $10,000. Thus in determining the best vacuum the item of tube renewals may have a preponderating influence. Furthermore, as between two condensers for the same vacuum, one of which requires less tubes than the other, it is manifest that the fewer the tubes the less the fixed charges.

Similarly, the longer the tube life the smaller the fixed charges and cost of power. In one plant the tube life might be five years and in others a great deal more or a great deal less. Tube life depends on the character of the water supply, on the chemical, physical and metallographic properties of the tubes (crystalline structure) and it also depends on the design of the condenser. The latest report of the Corrosion Committee of the Institute of Metals, London, summarizes the types of condenser-tube corrosion, principally general thinning, pitting and apparent dezincification. The fourth and fifth reports of this Corrosion Committee are exhaustive studies of the subject, and among other causes emphasize the effect on corrosion of low velocity and high temperature.

Velocity has a direct effect on corrosion. Low velocity allows the deposit of foreign matter in the tubes which forms obstructions around which the products of corrosion accumulate in concentrated form, with the resultant pitting. High velocity keeps the tubes clean and eliminates this form of corrosion.

High temperature accelerates corrosion of all types and so seriously that a temperature of 95 deg. Fah. is recommended as the maximum. There are three ways of reducing temperatures in order to alleviate corrosion: by increasing the water quantity thus decreasing the overall rise; second, by eliminating hot spots and local overheating of tubes; third, by increasing water velocity or decreasing tube size, thus decreasing the

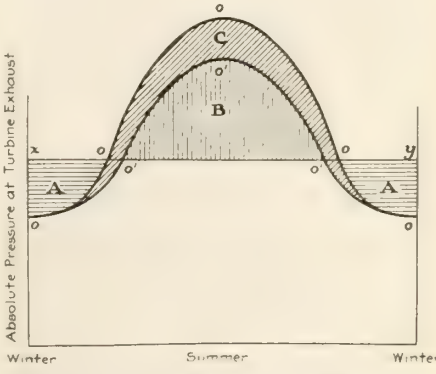


Fig. 2.—Cycle of absolute back pressure of gear line x y, represents highest vacuum or lowest desirable exhaust pressure. Areas AA represent waste in winter, due to excessive vacuum and areas B. & C. waste in summer, due to warm water and insufficient vacuum. Area C represents improvement possible by investing more money.

skin temperature at the tube wall. The first of these needs no comment. As to the second, it is well known that faulty steam distribution causes excessive heating of the water in some tubes counterbalanced by practically no heating of other tubes. Thus in condensers in which the steam distribution is obtained by lanes, the tubes in the path of the steam heat the water rapidly, but they short-circuit the tubes within the banks. The short-circuited tubes are not only wasted surface, but are the cause of the excessive temperatures in the exposed tubes, which consequently corrode rapidly.

The third method of reducing temperature, higher velocity and smaller tube size, may need explanation. It is well known that more heat is transferred for a fixed area of tube surface and fixed conditions of steam temperature and water velocity is increased or tube diameter reduced. The tube acts as though a colder water supply were being used and this is exactly what is happening because the water at the walls is really colder. The metal is therefore colder and can abstract more heat in the same time from steam at the same temperature.

The flow of water in a tube is accompanied by cross-currents and whirls which convey the heat from the walls into the body of the water. In Fig. 3, if thermometers were placed as indicated the temperature readings would follow a curve as shown. Increased velocity reduces the temperature at the walls, making the curve flatter. Similarly, using a smaller tube reduces the temperature at the walls and makes the temperature gradient flatter. The inner skin temperature may be approximated from various experimental results on heat transmission and curves obtained as in Fig. 4, which shows the relation between the water velocity and this inner skin temperature for conditions of constant load (Curve A) and constant vacuum (Curves B and C). In all cases increasing the velocity reduces this temperature.

In a condenser with proper distribution to avoid hot spots, and with suitable velocity and tube diameter to further reduce skin temperature and prevent foreign deposits, a markedly longer life of tubes will be obtained. As will be seen, too, these features of design result in small initial surface requirements, so that there is a twofold reduction in the fixed charges to take care of replacements.

Operating Charges

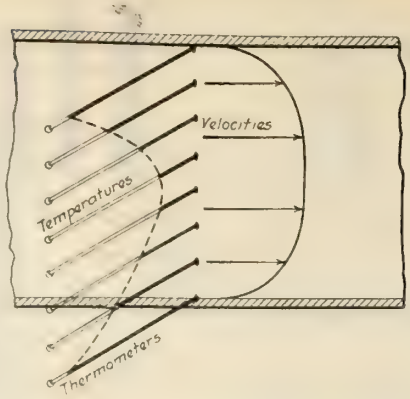
The principal operating charges on a condensing plant may be grouped as follows:

(a) Reduction of condensate temperature below steam temperature and consequent loss of coal.

(b) Power for operating the auxiliaries.

(c) Reduction of vacuum and increased coal consumption due to scaling and sliming of the tubes.

(d) Cost and time to clean the tubes and cost and time lost due to tube failure



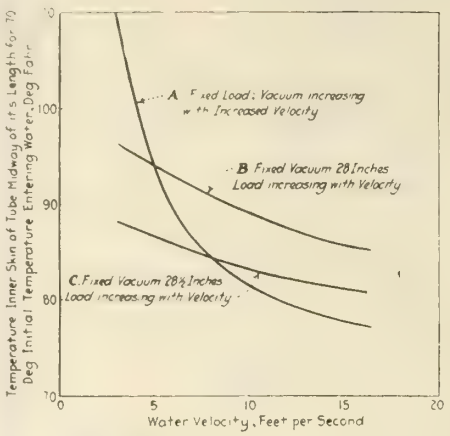

Temperature Inner Skin of Tube Midway of its Length for 70 Deg Initial Temperature Entering Water-Deg Fahr
A. Fixed Load: Vacuum increasing with Increased Velocity
B. Fixed Vacuum 28 Inches Load increasing with Velocity
C. Fixed Vacuum 28½ Inches Load increasing with Velocity
Water Velocity, Feet per Second
0
5
10
15
20
70
80
90
100

Fig. 3.—Influence of Water Velocity and Tube Diameter on Temperature Distribution.

Fig. 4.—Relation of skin temperature to water velocity at different loads and vacuums.

and consequent pollution of the boiler feed.

Reduction or Depression in Condensate Temperature below steam temperature depends on condenser design and temperature of circulating water, being less with warm water and greater with cold water. The water of condensation must fall over successive rows of tubes to reach the bottom and if the steam is not drawn down to the bottom of the condenser, the water will be gradually cooled. The cooler the water and higher the vacuum the greater the proportion of idle surface and the colder the condensate. Even in those condensers, in which numerous short-circuiting lanes are provided for the express purpose of securing penetration of the steam, there is a depression of condensate temperature of 5 to 10 deg. in summer and 10 to 20 deg. in winter. Eleven degrees loss of condensate temperature represents 1 per cent. loss of efficiency and is equivalent to 300 kw. on a 30,000 k.w. machine. In some plants this loss is largely overcome by the installation of preheaters.

Power for Operating the Auxiliaries has already been considered in a sense in the discussion of fixed charges, since the power required for any vacuum is partly dependent on the investment, and may be decreased by increasing the investment and fixed charges. No distinction should be made between the power required for driving condenser auxiliaries and the main power output of the plant, even where the auxiliaries are steam-driven and exhaust to a feed heater. The auxiliary power is a direct charge against the main unit output.

The principal item of power consumption lies in the circulating pump, and this unit is often arranged for variable-speed drive or else is divided into smaller units, so that with cold water or light load the operating charge may be reduced by slowing down or by shutting down one pump. As shown in Fig. 2, an excessive vacuum is obtainable in the winter and the waste of fixed charges can be partially offset by saving on the circulating-pump power.

The best balance of circulating-pump power in summer time for conditions of maximum water temperature and full load must be settled after consideration of all the aspects of the problem. By proportioning the condenser for low water velocities the head on the circulating pump may be made low, and the quantity of water used very low with small power requirement for driving the pump. This saving, however, may be counterbalanced by excessive fixed charges distributed over a relatively small part of the year. Thus suppose the investment were increased $5,000 on a 10,000-k.w. unit, and the circulating-pump power reduced by 50 k.w. The added fixed charges including tube renewals might be $1,000 per year, and if this be charged against the summer months, the rate might be 50 cents to several dollars per hour depending on the number of hours. This would offset 50 k.w. For this reason many plants use two pumps in the summer, working under relatively high heads of 30 to 40 ft.

Low pump power with low water velocities may be offset also by increased operating charges due to low vacuum resulting from fouling. Fig. 5 is similar to Fig. 2, except that a shaded portion D has been added to indicate the range of vacuum in the summer time under actual conditions of fouling of condenser tubes. As much as an inch of vacuum is lost in a week in some cases, and in one extreme instance there is a loss of an inch in two days. It is unfortunate that the loss by fouling is most severe in the summer when it is most difficult to obtain high vacuum. As a reduction of only ¼ in. in vacuum represents a loss of 1½ to 2 per cent. of turbine economy, which may be equivalent to all the auxiliary power, it is readily seen how easily all calculations of exact balance between fixed charges against the condenser and operating charges against the auxiliaries may be disrupted.

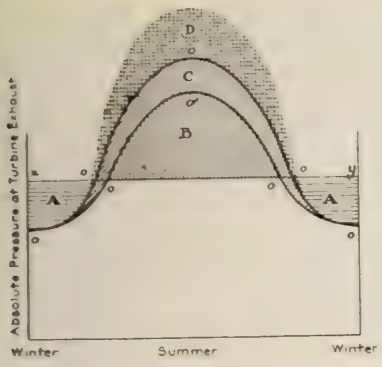
Reduction in Vacuum Due to Tube fouling. The foreign matter that accumulates in condenser tubes may be divided into three classes:

(a) Mechanical deposits, silt and mud.

(b) Scales deposited out of solution.

(c) Slimes or organic growths.

The first of these is of minor influence in reducing vacuum unless water velocities are low indeed. The ability of a stream of water to carry solid substances in suspension increases rapidly with increase of the velocity. However, foreign matter such as silt, may be deposited in the slime coatings which



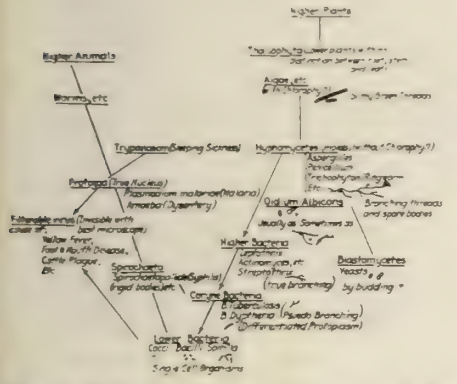


Fig. 5.—Cycle of absolute back pressures at different seasons. Area shows increased back pressure, due to fouling.

Fig. 6.—Forms of life in condenser tube slime.

form a more adherent surface than a clean condenser tube.

The second form of deposits is common with salt water and hard waters carrying scale-forming salts, familiar in impure boiler feedwater. In many cases with cooling towers or spray ponds the source of make-up is a relatively hard water and causes deposits of sludge and scales in the condenser tubes. The commonest ingredients of such water are calcium and magnesium carbonate which are soluble in the presence of carbon dioxide. Heating the water drives off the CO_2 and precipitates the carbonates.

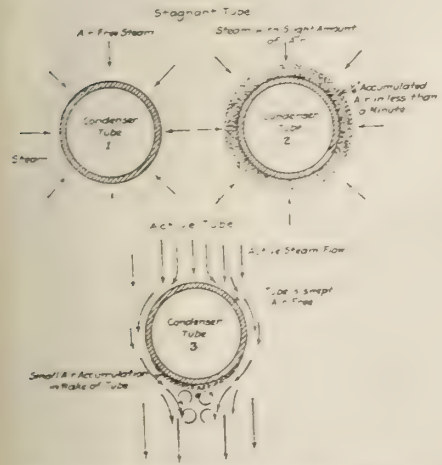


Fig. 8.—Importance of steam velocity in preventing stratification of air around a condenser tube.

Stagnant tube: Condition when steam flow is produced by avidity of tube itself from condensing steam.

Active tube: Condition when there is active steam flow to sweep tube free of air.

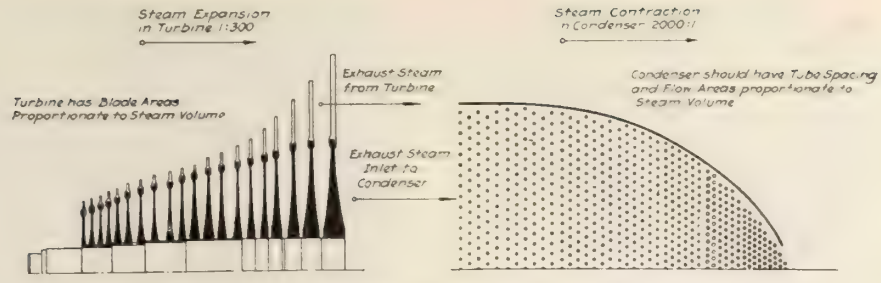

Steam Expansion in Turbine 1:300
Steam Contraction in Condenser 2000:1
Turbine has Blade Areas Proportionate to Steam Volume
Exhaust Steam from Turbine
Exhaust Steam Inlet to Condenser
Condenser should have Tube Spacing and Flow Areas proportionate to Steam Volume

Fig. 7.—Comparison of steam flow in turbine and correctly designed condenser.

The influence of uniform steam distribution, smaller tube size and high water velocity on reducing skin temperatures has already been shown. It is also probable that high velocity has a mechanical effect in reducing the rapidity of such scale formations. In sugar evaporators it is commonly found that the tubes which work actively and therefore contain rapidly rising currents of mixed vapor and juice, scale the least; whereas tubes doing less evaporation foul more heavily.

Where extremely hard waters are encountered it is desirable not only to keep down the temperatures by observing the principles of high skin velocity and activity, but also by using larger quantities of water and smaller overall temperature rise. In this way it is possible as between two condensing plants to reduce the maximum temperature rise of the skin of water in the hottest tubes, 10 or 20 deg., or even more.

Slimes or organic growths are the third form of deposits. Fouling of this character is most severe in the summer time, and is also most severe in hot portions of a condenser with improper steam distribution. Thus, in a condenser with lanes, the tubes in the lanes will be found coated with thick, heavy slime in a short time, whereas tubes in the short-circuited regions will be but slightly fouled. It is probable that these slimes are organic growths occurring under the ideal conditions of warmth and stagnation existing at the inner skin of the tube. A typical sample of condenser-tube slime was taken a short time ago by the author and given to a bacteriologist for analysis. A large number of hyphomycetes were demonstrated. This form of life is classified between bacteria and plants, as shown in Fig. 6. The hyphomycetes grow rapidly as long microscopic threads (Mycelia), which branch rapidly, forming a dense interlacing network in which all other organic and inorganic elements are caught. They grow better in an acid than an alkaline medium. The hyphomycetes are familar to us as molds and fungi and are a form of life just below the algae, which are the green slimes frequently seen in stagnant pools. The algal contain chlorsphyl and require light for their growth, whereas the hyphomycetes grow in the dark. The conditions for rapid growth are moisture, stagnation and a fair warmth. The optimum temperature is between 20 and 40 deg. cent. (68-104 deg. Fah.); when spores are formed they are more resistant to higher temperatures.

There are cases on record of two condensers side by side, one with low velocity the other with high velocity, in which the latter remains cleaner for longer periods. Similarly it is well known that condensers do not lose as much vacuum or have to be cleaned as frequently in the winter as in the summer, and also that those parts of the condenser that are hot foul more rapidly than those where the water is not heated. In one instance a condenser is so large that it is cleaned only part at a time and when this practice was initiated the operating force found that cleaning the two lower quarters and one upper quarter improved the vacuum very slightly, whereas cleaning the last quarter which was exposed to the full activity of the steam brought the vacuum back to normal. In this section, the tubes exposed to steam are so heavily fouled that two men are needed sometimes to push the brushes through. The same arrangement of tubes to prevent local overheating, and the use of high water velocities to reduce inner skin temperatures and increase the activity and counteract stagnation along the inner wall of the tube, may be expected, therefore, to reduce and eliminate the formation of organic slimes. Corrosion, scaling and sliming can all be reduced by correct proportion of a condenser for high activity of water flow and turbulence at the tube wall and uniform steam distribution, factors which in addition permit of a large reduction in the amount of tube surface.

Fouling adds to the operating charges in another way, as there may be a large labor cost for cleaning. The time loss with a unit out of service is also a con-

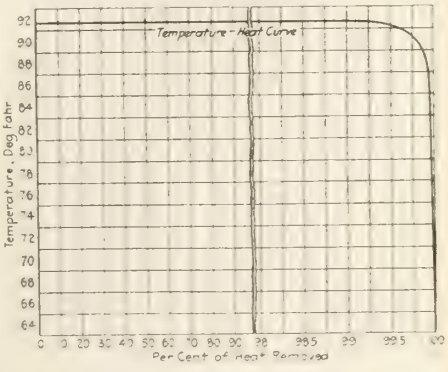


Fig. 9.—Relation between percentage of heat removed from a mixture of steam and air and temperature of the mixture.

Note:—Scale is magnified 40 times at right hand section of chart for the assumed mixture which is a fair average in high vacuum condensers. The temperature starts to fall at 99 per cent.

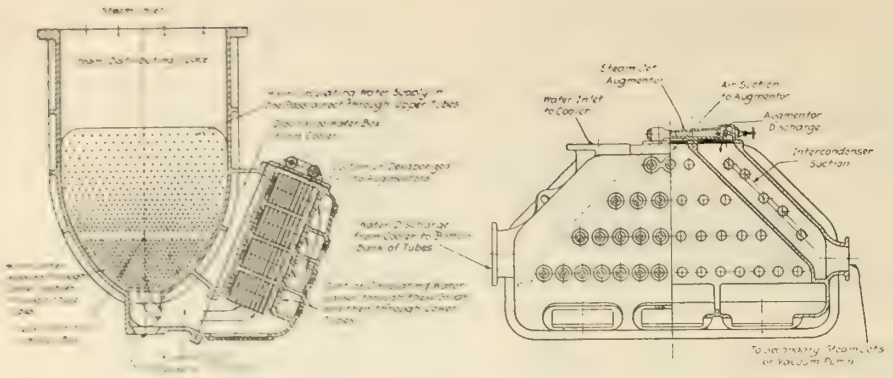


Fig. 10.—Cross section through main condenser and cooler of surface condenser.

siderable item of cost. The charges due to failure of tubes by splitting and corrosion are of a similar nature. The pollution of the condensate and consequent scaling of the boilers from either impure condensate or from raw feedwater adds to the operating charge in the boiler room. The loss of time on the complete power-generating unit required to shut down, locate, and plug the leaking tube adds to the turbine-room operating charges.

Clogging of Tubes. One other loss adding to operating charge is that caused by clogging of tubes by accumulation of miscellaneous solid substances against the tube sheet. This applies only to plants using natural water supplies. With spray ponds the nozzles clog long before the condenser tubes. Clogging can be reduced by proper screening, and the use of flush, well-rounded tube inlets and high water velocities. Low velocities are wanted in the screens, but high velocities and clear inlets into the tubes. The influence of velocity is clearly shown by the tendency in two-pass condensers for the tubes of the return pass to clog with solid matter which originally came through the first pass. This clogging is most noticeable toward the top (where the water is needed most) and is due no doubt to the slow velocities at the top of the return box, which is at the top of the siphon and acts as a skimming tank.

Condenser Design

The design of a surface condenser to conform with the requirements which have been outlined, lies in the proper application of certain well-known principles. The first of these is to keep all of the tubes uniformly hot on the steam side so that the minimum number will be needed because none are wasted. To accomplish this the steam must be free to flow to all the tubes and over all the tubes, with slight loss of pressure and temperature, the condenser being arranged in stages, much as is a turbine, with large flow areas at the exhaust entrance and great distances between rows to avoid sharp bends and pressure loss. Fig. 7 illustrates the analogy.

Of equal importance in keeping all tubes hot is the proper staging to maintain velocities that will sweep the air ahead in the current of steam and the arrangement of tubes in staggered rows so that none is shielded or pocketed. Air left on a tube after condensation would otherwise stratify in a thick layer in a few seconds. With rapid steam velocities as shown in Fig. 8, all of the tube is hot because the air is continually carried away in the current of steam. Experiment has shown that this current is most active in producing heat transfer in front of the tube; the side about 90 per cent. active, and the back about 75 per cent. This indicates the importance of a staggered tube arrangement so that the front of each tube is presented to the steam flow.

The steam velocities must be sustained throughout the depth of the condenser, which not only requires proper tube spacing but a shell of decreasing width—that is, a wedge or heart-shaped shell terminating in a narrow, slot-shaped outlet. In this respect also the condenser is analogous to the turbine, Fig. 7, which has both changing blade height and changing wheel diameters.

If the foregoing conditions are maintained, the mixture of steam and air is kept homogeneous and the temperature does not fall until a surprisingly large percentage of steam has been abstracted and the process almost completed. Fig. 9 shows the relation between percentage of heat removed from an average steam-air mixture such as would enter a condenser, and the temperature of the mixture. Starting with approximately 92 deg. temperature there is no perceptible fall of temperature due to increasing air richness until over 99 per cent. of the heat has been abstracted and over 99 per cent. of the steam condensed. Thereafter the temperature falls with a marked knee in the curve, the exact position and shape of which depend on the proportion of air to steam in the original mixture.

This process is no longer rapid condensation but a matter of devaporization, to reduce vapor temperature and pressure and increase partial air pressure so that the air may be removed by a vacuum pump. It is best carried out in a chamber external to the main condenser forming a devaporizer or cooler. Figs. 10, 11, and 12 illustrate such an arrangement in which the flow of hot vapors and air taken from the bottom of the main condensing chamber is turned upward into a cooler from which the concentrated air is finally removed at the top. It will be noticed that this cooler is also of wedge shape, decreasing in area as the outlet is approached. The air is withdrawn by steam-jet augmenters which discharge into an intercondenser section forming part of the cooler. The air at reduced vacuum is then withdrawn and compressed to atmosphere by secondary steam jets or a small reciprocating pump. In one case a single small pump is used as a secondary for two condensers, steam-jet secondaries being installed as stand-bys.

The work of devaporization is done by cast-iron grids with fins, meshed together as illustrated in Fig. 13. Cold circulating water flows through the cores of the grids with only slight rise in temperature and then passes through

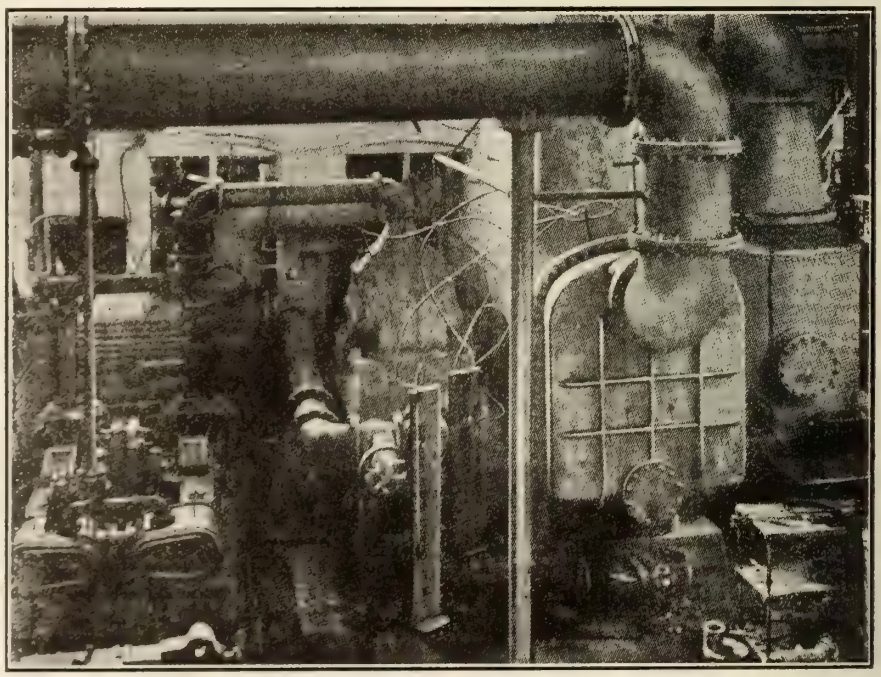
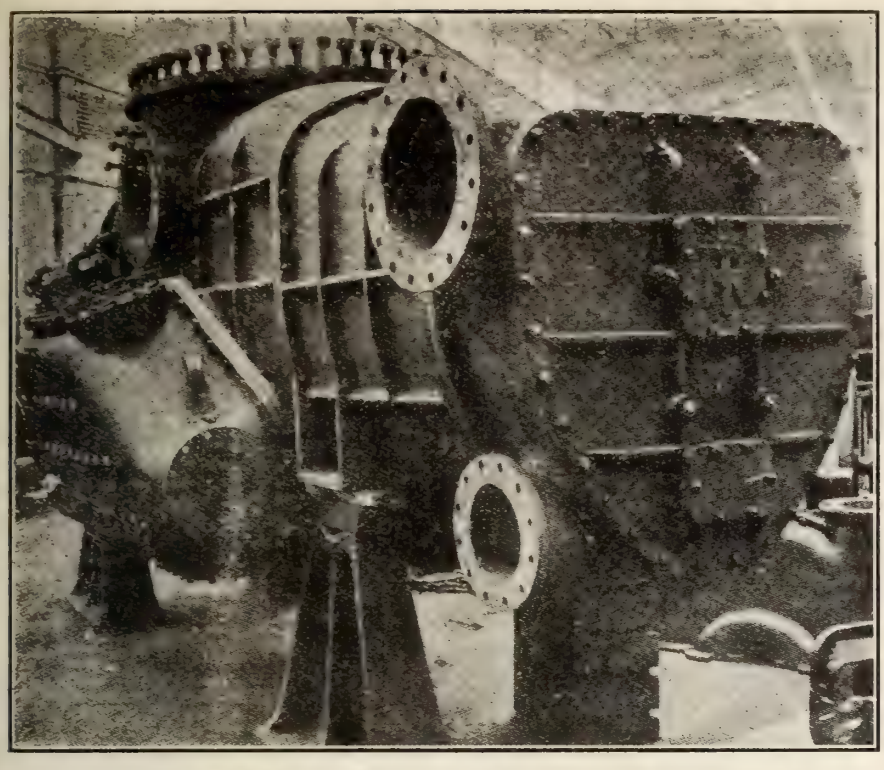


Fig. 11.—Large experimental surface condenser plant at works of Ingersoll Rand Co.



F'g. 12.—I-R Surface Condenser from inlet water box end. At the left is cooler mounted on shell.

the bottom group of tubes in the condenser (Fig. 10).

A large experimental plant, for capacities up to 70,000 lb. per hour was built at the Phillipsburg works of the Ingersoll-Rand Company to investigate these departures in design. The photograph reproduced in Fig. 11 illustrates the complete plant. By the use of electrical thermometers the performance of each row of tubes was determined and from that the efficiency of the tubes under all conditions of loads, vacuum and air leakage and in different parts of the condenser. A sliding or "trombone" thermometer of the electrical resistance type in the discharge water box was arranged so that it could be shifted to any position desired. Decks were fitted in the box which could be shifted to vary the water distribution so that a wide range of conditions of water circulation was obtained. It was found that high efficiency was obtained down to the last row of tubes of the condenser so long as certain critical conditions of vapor velocity were maintained. The condenser was hot throughout its depth and the condensate water at practically steam temperature. The hydrodynamic loss or pressure drop was also studied by the use of water manometers, from which spacings, and number rows were determined.

Fig. 13.—Showing Guds As Meshed When Assembled in cooler.

Depending on the air leakage, the cooler devaporizes and cools the air down as close to the temperature of the cold circulating water as one degree, thus giving complete countercurrent action. A study of these temperatures was made by electrical thermometers located at successive points as shown. As is well known from Dalton's law, the amount of air contained in a homogeneous flowing mixture of steam and air depends on the temperature and corresponding action gives maximum withdrawal capacity of the vacuum pump and protection against excessive reduction of vacuum due to heavy air leakage.

It is evident that with the cooler taking care of the process at the knee of the curve and the main condenser hot and active throughout its depth, water cannot pass through great groups of tubes without heating, and therefore the entire bulk of the circulating water can be heated with only one passage through the tubes instead of multiple passes. The circulating water may be pumped, therefore, at low head and power consumption, with high average rate of condensation since none of the tubes are wasted, or else at greatly increased velocities and correspondingly increased rates of condensation. The main supply of water passes directly through the upper and larger group of tubes and the remainder of water after passing through the cooler, goes through the lower and smaller group of tubes below the deck or partition.

The rate of condensation in a condenser with all its tubes active was found to vary substantially as the rate of condensation on a single tube, which, as is well known, depends on its diameter and material and the water velocity. With only one passage necessary, an entirely new basis for selection of velocity and tube size is opened to the designer. High velocity or small tubes or both can be used without excessive pump power as would be encountered with multiple-pass construction. Paradoxically, there is more insurance against corrosion, as well as greater protection against reduction of vacuum by scaling and sliming, when working the condensation rates. The author does not wish to imply that excessive pump powers should be used. High capacities and velocities may be obtained without exceeding circulating-pump powers now often used. The circulating-pump capacity is best arranged in twin units so that maximum water quantity and velocity are available in summer and can be reduced in winter by shutting down one pump. Variable or graded circulating-pump capacity is desirable in small as well as large units.

On large units having two water pumps, one of which is shut down in winter, provision can be made for preserving high velocities even with reduced water quantity. At high vacuum with cold water, the top tubes in large condensers do most of the work and therefore the smaller winter quantity should be concentrated on these tubes, thus maintaining high velocities in the tubes which tend to foul and corrode.

In the summer time both pumps supply water to the two nozzles (Fig. 14) serving sections A and B, and a small quantity of water is supplied the coolers and from them to section C at the bot-

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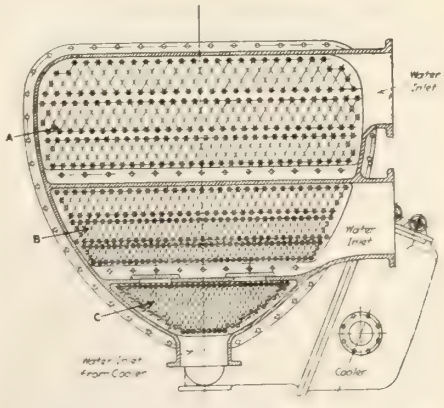


Fig. 14.—Water Box with two injection nozzles on I-R Surface Condenser.

Both nozzles are used in summer, the upper one only in winter, thus obtaining high water velocity even with reduced water quantities, and concentrating condensing action in top of condenser.

Report of the Bureau of Locomotive Inspection

A Summary of the Chief Inspector's Report for the Year Ending June 30, 1921. Some Points of Interest to the Stationary Engineer Are Embodied in This

INSPECTION in the U. S. is doing a great work, and its reports are always of considerable interest. The latest one to hand is no exception to this rule. The report under review is for the year ending June 30th, 1921.

The law covering the inspection of locomotive boilers in the U. S. came into force in the year 1912. Previous to that there were no statistics of accidents to boilers and fittings with which to make a comparison, but there is ample opportunity to make them between the year 1912 and the years in between up to the date of the present report.

The following tables show some of these comparative figures:

	1921	1920	1919	1918	1917
Number of locomotives inspected	60,812	49,471	59,772	41,611	47,542
Number found defective	30,207	25,529	34,557	22,196	25,909
Percentage found defective	50	52	58	53	54.5
Number ordered out of service	3,914	3,774	4,443	2,125	3,294
Total defects found	104,848	95,066	135,300	78,277	84,883

Number of accidents, number killed, and number injured as a result of failure of parts and appurtenances of the entire locomotive and tender, by years.

	1921	1920	1919	1918	1917
Number of accidents	735	843	565	641	616
Decrease from previous year (per cent)	12.8	[1]49.2	11.8	[1]4.1	.....
Number killed	64	66	57	46	62
Decrease from previous year (per cent)	3	[1]15.8	[1]23.9	25.8	.....
Number injured	800	916	647	756	721
Decrease from previous year (per cent)	12.6	[1]41.6	14.4	[1]4.8	....

[1] Increase.

The comparative table below for the fiscal years ended June 30, 1912, 1915, 1920, and 1921, shows the number of accidents, number of killed, and number of injured as a result of the failure of some part of appurtenance of the boiler only:

	1921	1920	1915	1912
Number of accidents	342	439	424	856
Number killed	51	48	13	91
Number injured	379	503	467	1,005

Derailments due to defects in or failure of some part of the locomotive or tender and the number of persons killed and injured as a result of such derailments for the fiscal years ended June 30, 1917-1921, inclusive.

	1921	1920	1919	1918	1917
Number of derailments[1]	8	7	7	2	4
Number killed	....	7	6	.....	1
Number injured	30	18	7	2	21

[1] Only derailments reported by carriers as being caused by defect in or failure of parts of the locomotive or tender were investigated or counted in this tabulation.

A comparison of the year 1915, in which the boiler law was amended, and the year 1921, shows the beneficial effect of proper inspection on the casualty lists.

Comparing the number of accidents, due to the failure of some part or appurtenance of the boiler, in the year 1912 with those in the year 1921 there is a reduction of 60 per cent. while in the number killed there is a 44 per cent. reduction, and 2 per cent in the number injured. It is noted in the report that explosions of boiler barrels, has practically ceased, and the failure of crown sheets has decreased considerably. It is noted however, that these failures are of a much more serious nature than formerly, as the number of killed is higher while the number of accidents is lower.

It is interesting to note that the report attributes the severity of these fire box failures to the use of autogenous welding. It states that where a failure takes place on a seam which has been welded, it is usually much more serious than it otherwise would have been. The report states that while autogenous welding can be safely applied on parts of the stayed surfaces of boilers, they should be avoided in fire boxes seams where overheating is likely to occur, such as crown sheet seams. It is shown that where these welded seams are involved in accidents, 80 per cent of them fail, and that therefore welded seams should not be used unless the stresses on the part are carried by other construction apart from the welding.

This does not mean to say that autogenous welding must not be used in any case, but that where the stresses coming on the plate are only resisted by a welded seam, it is not sufficient to give the requisite margin of safety. The report says "This at least until some means has been developed through which the quality and tenacity of the weld may be established in advance of its failure."

The report then gives some figures on the energy contained in water under pressure, and on the energy liberated in a particular case. The actual words of this portion are "The force of a boiler explosion is in proportion to the size and suddenness of the initial rupture, and the temperature and volume of the water in the boiler. The average modern boiler has a capacity of approximately 500 cubic feet of water below the crown sheet and has a steam space of about 150 cubic feet. If such a boiler with 200 pounds pressure ruptures from any cause, so as to suddenly reduce the pressure to that of atmosphere, the released energy will amount to approximately 700,000,000 foot pounds and if the explosion took place in two seconds approximately 90,000 horse power would be developed." The causes of boiler explosions are given as abnormal steam pressure, weakness in design or construction, improper workmanship, corrosion or wasting away of material, broken or defective stays, overheated crown or fire box sheets.

Water Gauge Glasses

The report draws attention to the difficulty of securing a correct indication of the height of water over the crown sheet under all conditions of service. It has been established by the Bureau's investigations that gauge cocks screwed directly into the shell of the boiler do not give correct indications while steam is rapidly escaping from the boiler, and the use of a water column with try cocks and a glass gauge is recommended.

Fire Doors

The report strongly recommends that all boilers on which oil fuel is not being used should have a mechanically operated fire door, which can be operated by a foot pedal situated at a proper distance from the door, so that it can be closed without the fireman or engineer having to stand in front of the fire while so doing. This recommendation is the result of so many accidents happening through failure of tubes or sheets by which the steam pressure has been liberated into the fire, blowing it out along with steam and boiling water into the cab of the locomotive. As these accidents often happen while coal is being put in the furnace, the mechanically operated door is regarded as a safe guard. It also tends to longer life of the boiler and better economy, as the door would be shut between each shovelful of coal, and the tendency to cause cracks round the door through cold air striking the plates would be minimised.

This automatic door is not a new thing, having been used in connection with water tube boilers in both the British and U. S. navies, and being compulsory in several states of the Union.

Injectors

An instance is given where the bonnet of the steam inlet of an injector blew off, resulting in the death of an employee. The cause of this was a thread on the bonnet that had been worn to such an extent that the bonnet dropped in up to the two last threads before the threads engaged. The damage to the

threads had been caused by the use of hammer and chisel for slacking off and tightening the bonnet, and such practice is strongly deprecated.

This is a point that could be well borne in mind by a good many engineers, who are very apt to use this method in preference to taking the trouble to find the proper spanner or wrench to do the job.

The general trend of the report would show that since the inspection law has been in force a considerable decrease in accidents has taken place, and emphasises the beneficial effect of such inspections when properly carried out.

There can be little doubt of this, as it has been the experience of every place where a thoroughly enforced inspection law has been put into force, and where the inspectors employed have been up to the requisite standard.

EDUCATION AND FUEL CONSERVATION

The average steam plant wastes one quarter of its fuel. The domestic consumer of fuel is even more wasteful than the industrial consumer. The mineral fuels can never be replaced. Once exhausted they will be gone forever, and there is not—as is popularly supposed—an inexhaustible supply. Oil is going fast; anthracite will soon be gone; and the thick-vein low volatile coals of the eastern field are almost gone. The problem of fuel conservation is therefore, one of world importance to all of the people of all the world.

The many problems that have a bearing upon fuel economy are of vital importance to the individual fuel consumer. He pays for the fuel that he uses and his annual bill depends upon two things, viz: the price per ton or per gallon that he must pay and the quantity that he uses. He has no control—or at the best, the most remote control—over prices, but he does have a large measure of control of the quantity that he uses. The average consumer can reduce the quantity of the fuel that he uses at least twenty-five per cent. This is the estimate of many competent engineering authorities.

Let us, for example, suppose an industrial concern needlessly wasting one-quarter of its fuel. Every dollar that is saved to the fuel account can be passed to the dividend account. Every stockholder of every company relying upon steam power should be deeply concerned with the fuel bill, because fuel is a very large item of manufacturing expense in nearly all industries. We are entering upon days of very sharp competition and the industries to survive will be those that give close attention to the cost of production.

Fuel economy depends primarily upon the education of all those who have anything to do with the final uses of fuel—from the manager in his office, down to the men who actually burn the coal, oil or gas. Knowledge is necessary, no matter how refined the equipment for the utilization of the fuel may be. The more refined the equipment, the more refined the knowledge must be.

The United States Fuel Administration very early in its short-lived career, realized that education was the real key to fuel economy and it set about a campaign of instruction. The work of the Fuel Administration came to an end with the close of the Great War, but in giving up its campaign it reported as probably its most important finding and message to the country, that the work of conservation must go on primarily through the better education of the American citizen in the theory and practice of combustion. The man who studies fuel economy is certain to effect fuel economy.

BOOK REVIEW.

We have received from the U. P. C. Book Company, 249 West 39th Street, New York, "Burning Liquid Fuel," by William Newton Best, F. R. S. A., A. S. M. E., etc. The book contains a foreword by Rear Admiral John R. Edwards, U. S. N., in which he calls attention to the peculiar fitness of the author to deal with this subject. There is also a preface by the author.

The first chapter is devoted to the author's early experience in the use of oil fuel, which goes back to the time of his superintendency of the Los Angeles Electric Railway in 1887. Since those days Mr. Best has equipped practically every form of furnace in existence with oil fuel burning apparatus, and therefore is well qualified to speak on the results attained and to be acquainted with different installations. The origin production and analysis of liquid fuel are dealt with in chapter two, and this chapter contains a fund of information on these departments of the subject. Atomisation, oil systems, locomotive equipment and marine and stationary boiler equipments are dealt with in subsequent chapters. Refractory materials for use with oil furnaces, commercial gas practice, heat treatment furnaces, forge shop, sugar industry, etc., are dealt with very fully.

A feature of the book is the profusion and excellence of the illustrations. The volume fills a very long felt want, and is the most complete treatise on this subject that has come to our knowledge. The book sells for $5 net in the United States.

OTTAWA LODGE C. A. S. E.

Ottawa Lodge, No. 6, C. A. S. E. held one of its special open Educational Meetings on Wednesday evening, February 22nd, in their (Huckels) Hall, Cor. Bank & Frank Streets.

The subject of the evening was a very interesting lecture on Refrigeration, which was very ably given by Bro. Arthur G. Pedder, A. M. E. I. C., of the Ottawa Electric Company, accompanied by lantern slides.

There was a very large attendance of members and visitors and to judge by the interest taken by all present, Bro. Pedder's lecture was a huge success and highly appreciated by all.

Ottawa Lodge is coming forward steadily and adding some excellent and valuable material to her already good list of workers.

TORONTO LODGE C. A. S. E.

At a recent meeting of the C. A. S. E. Toronto, No. 1, Mr. Jno. Farmer, M. E. of No. 314 Caristine Bldg., Montreal, gave a very interesting lecture on the means for determining CO_2 and the importance of CO, recorders. Because of the very general lack of information on the above subject his lecture was more or less elementary and yet it proved very interesting. There was a very good attendance and a very hearty vote of thanks was extended Mr. Farmer.

Anyone who attended the lecture will hereafter say they have "No Cash."

GUARD THE OIL CAN

It is doubtful if any single piece of shop equipment gets less consideration than the small oil can which is so often seen resting on or near every class of machine tool. Yet the efficiency of the mechanism depends in no small measure on the careful and judicious handling of this small can. The purpose of the oil can is to store small quantities of lubricating oil so that the same can be conveniently applied when occasion requires.

When oiling bearings or sliding surfaces it is important to guard against any foreign substance getting into the oil holes or passages that will destroy or interfere with the free movement of the parts; and yet how often will an observer see an oil can knocked off a machine into a pile of cuttings or dirt, and picked up and used without any attempt to clean the spout before inserting it in an oil cup or oil hole. This form of neglect or carelessness may not be a general one but it is common enough to bring to the attention of those readers who may be desirous of seeing the "insignificant oil can" given the attention it is duly entitled to.

A NEW TYPE OF HIGH EFFICIENCY CONDENSER

Continued from page 25

tom of the condenser. In winter one pump is shut down, the valve to section B shut, and the plates in the deck between B and C removed thus throwing these two tube banks in parallel so that they both receive water from the coolers. The main water supply is then concentrated on the upper section A. This design also has the advantage that at any time the entire capacity of the two pumps may be concentrated on section A or B, thereby producing extremely high cleaning velocities, also, that either section A or B can be shut down independently and the water-box covers removed for inspection or cleaning.

Compounding the Combustion Engine

After Years of Research a Compound Type of Internal Combustion Engine Has Been Developed and Has Been Subjected to Long and Continuous Runs—The Engine is Four Cycle

By Elmer A. Sperry
President The Sperry Gyroscope Company, M.A.S.M.E. Paper Read Before The American Society of Mechanical Engineers.

THE high-compression or Diesel cycle in combustion engines has worked nothing short of a revolution, having brought to the prime mover its choicest heritage, the highest thermodynamic efficiency known. The fuel economies of these engines have forced them to the front. They have become extremely reliable and easy to operate; instances are becoming common of long runs without overhaul—long-continued performance without shutdown or forced stop of any kind.

As experience is gained with these engines however, there have developed some objectionable features which are serious. Though they occupy somewhat less space than boilers and engines, the weights of Diesels are on a par with, if not somewhat in excess of, those of reciprocating engines with their boilers and decidedly in excess of those of water-tube boilers and turbines. The standard product of the largest builder of Diesel engines for the merchant service weighs about 450 lb. per shaft horsepower and is large and bulky. A substantial increase in tonnage of freight carried is only one of the gains that would be secured, could these engines be made much lighter and smaller for the same power.

The weight is not the only difficulty with these large engines, however, for they cost more than steam equipment of equal power. One instance of $200,000 excess for a 3,500-s. h. p. ship is cited. In another ship for the same service and of the same power the weight was 60 per cent. in excess of the turbine equipment and the cost 212 per cent. amounting to $306,000 excess. Notwithstanding this extra capital charge, the first ship at three-fourths capacity in the Far East trade can earn nearly double net (83 per cent.) over its turbine competitor of the same power and construction and with its machinery weighing a third more than steam equipment.

Again, it has been found that almost without exception a grade of fuel oil known as Diesel oil must be employed. This is a partially refined product costing upon the present market considerably more than bunker oil burned under the boilers.

The fuel-oil problem in itself renders some advance absolutely imperative. Conservation of our oil should be backed by Government enforcement to stop the prodigal waste which results from bulk or furnace firing of enormous quantities of these highly concentrated fuels, destroying three to five times the quantity, power for power, required by steam, especially now since the cheapest petroleum can yield to the full its wonderful store of energy in the most direct way possible by being burned drop by drop directly in the cylinder and practically at the point where the work is to be done.

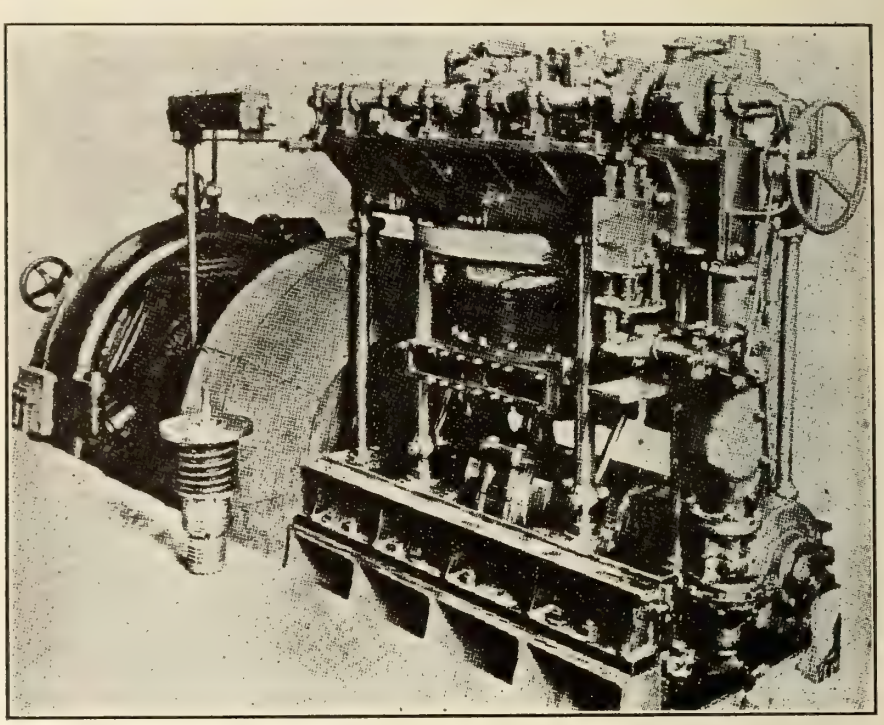


Fig. 1.—10 to 1 compound oil engine built for heavy duty.

Compounding as a Remedy For Inherent Difficulties With Diesels—The Author's Early Work.

In a report made by a group of engineers in 1900, it was stated that if the combustion engine could be successfully compounded, a most important gain would be made in its weight and size. The fact that compounding presents other advantages has been known to engineers for a number of years, but the difficulties have been looked upon as insurmountable.

A year ago Professor Watkinson, director of the important engineering laboratories of Liverpool University, in discussing an epoch-making paper by Engineer-Commander Hawkes on the Admiralty's extensive research on Diesels, stated, in substance, that we must recognize that the combustion engine in its present state was very crude and in compounding only lies the line along which the next great step in progress would be made. And he also stated that much greater results are bound to follow the compounding of combustion engines than were ever realized by compounding steam engines; first, because of the very much greater range of pressures available, and secondly, because the great enemy to compounding in steam, viz., condensation, is not present.

Activity in this field is now prodigious and workers in various parts of the world are commencing to realize that a great advance step is imminent. In America, a group headed by the author has been engaged on this problem for upward of thirty years. Starting in 1890, his first compound was running before the World's Fair. The patent records give evidence of this early work under date of December 10, 1892. A number of engines have steadily followed each other, each involving improvements resulting from previous experience, until the essential problems have been conquered. Not only has the principle been thoroughly established, but all the important refinements have been subjected to long continuous runs. Data almost invaluable to the art have been secured, together with a series of indicator cards and diagrams that exceed a thousand in number.

The outcome has been that the various prophecies of thoughtful engineers in the past have been more than fulfilled and there is every evidence that the heavy-duty compound combustion engine is everything that was hoped for. It is light compared with the normal

Diesel, being in special cases less than one-tenth, and in some instances less than one-twentieth, in weight for the same output. Its mechanical efficiency is extremely high and a distinct gain in overall efficiency from fuel to shaft has been made, as well as a very definite gain in simplicity, direct performance and smoothness of the crankshaft diagram. This has been achieved while adhering to the best practice, namely, four-cycle operation.

Compounds Lighter and Cheaper—Much Larger Units Possible

The lightness and simplicity of the compound solves the capital-charge factor automatically. Engines of this type weighing only a fraction of the weight of the present Diesel will inevitably be found to be much less in first cost as well as in cost of upkeep.

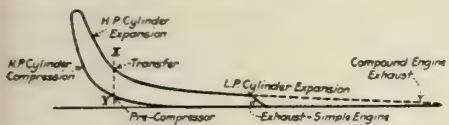


Fig. 2.—Indicator card of compound Diesel Engine.

Much higher powers than are now available are thought to be of extreme importance and much interest is centered upon the question; in fact, the more advanced among the Diesel builders are to-day concentrating upon ways and means to attain still higher powers from a single cylinder working on its present cycle. Of course this will increase instead of decrease the weight per horsepower. It is to the compound that we must look for a solution of this problem, for the reason that within present cylinder and cylinder-wall limitations, powers in excess of 10,000 h.p. per engine are entirely practicable and are accompanied by all the proportionate savings in weight, space and capital charge that have been pointed out.

Our own Government has watched the progress of this work for a number of years, inspected the development in its various stages, and has come forward with orders for an initial engine which, together with orders from other sources, is now under construction. To illustrate to what low figures the compound principle can be relied upon to bring the heavy-oil engine, it should be stated that among these orders is one now under construction to weigh about five pounds to the brake horsepower. This may be looked upon as extreme, but the designed weights and finished parts as they now stand are below this figure. This brings us within striking distance of aviation engines, where the fire risk through the presence of gasoline and the electric ignition system constitutes one of the greatest menaces to aviation progress. The remarkably high mean effective pressures of the heavy-oil compound will give us the aviation engine and entirely eliminate both these sources of fire risk.

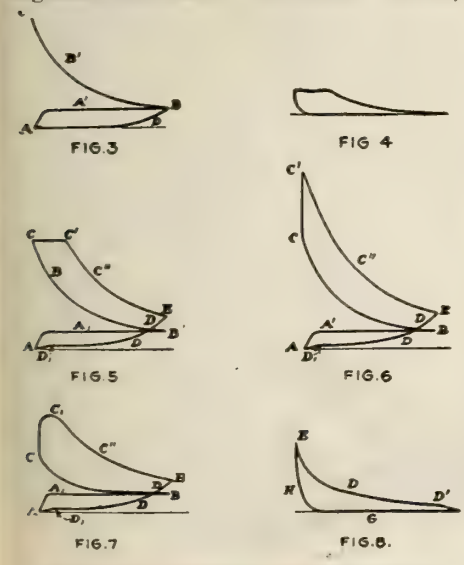


Fig. 3 to 8:—Indicator cards of compound cycle.

The reason for the great weight in all classes of Diesel engines is apparent when it is understood that they are designed around an extremely small quantity of air and oxygen at each stroke, an amount so minute as to be quite surprising when compared to the ponderous engine itself. The volume of the power gases available to do the work is limited to the size of the combustion space, and when it is remembered that this is confined to a small crevice in the end of the cylinder of the order of one-twentieth of the travel of the piston, the limitation is at once seen. Attempts to make it larger produce both compression and ignition temperatures that are too low and we have semi-Diesel and surface-ignition engines confined to smaller sizes with tendencies to a lower grade of performance. Such engines are difficult to start and represent no gain in weight.

Two of these volumes are sometimes combined as in the opposed-piston Junkers engine. The size of the combustion space, though still minute, is known to give some small advantages over the regular engine which has only one-half of this space, but has the disadvantage in common with all two-cycle engines of the fractional piston-ring support practically without lubrication on the hot bridges as the exhaust port is uncovered by the piston.

Separate Cylinders Suited to Pressure Ranges—Two Stage Compression Secures Large Working Volumes

Take, for instance, the Diesel indicator card, Fig 2. Draw the vertical line XY and it is easy to see that the expansion pressures to the left are high and should do their work in a high-pressure cylinder, whereas those to the right, especially following the dotted extension line of expansion, are definitely low pressures and should do their work in a low pressure cylinder for the purpose. This is practically all that is attempted in compounding combustion engines. The vertical line XY also divides the compression curve into two stages, low and high, the latter taking place in the combustion cylinder proper as a second stage. No compressor delivering 500 or more pounds per square inch will undertake to do so in a single stage; there would be at least two stages. The old single-stage compression is discarded in the compound and this modern method of two-stage compression is adopted.

Supercharging or compressing in two stages gives the controlling advantage in that a very much larger unit volume of gases may be handled. The clearance spaces may be many times the size of those in the Diesel, and yet it is perfectly simple to bring these large volumes up to the requisite pressure and incandescent temperatures at the instant of fuel injection.

The large volume of power gases in the combustion chamber of the compound at once solves a number of important problems, makes the light engine easy of accomplishment, and overcomes a number of other difficulties at the same time. No longer is the chilled perimeter per unit volume of gas the controlling factor, as it is in the Diesel. The chilled walls are retired into the background as the large volume asserts itself, as compared with the small crevice indicating the total volume available in the normal Diesel (shown at C in Fig. 9), where the chilled areas exposed are very large and the volume very small. At a glance it will be seen that all this is reversed completely in the large dome-shaped clearance space D in Fig. 9, where the volume has increased very much more rapidly than the perimeter. This is again vastly increased in the low-pressure cylinder, where an extremely large volume exists with still smaller ratio of chilled perimeter. Taking all of the chambers into consideration, it is found that while retaining all of the chilled walls that are necessary for proper handling of the lubrication, still a gain is made on the order of 60 per cent. in the extent of these chilled walls in the compound as compared with the simple engine.

With the large clearance volume we no longer have difficulty with solid injection, nor do we have any difficulty in using a wide range of heavy fuels. It has been known for years that as soon as the oil spray encounters chilled or even red-hot walls, the efficiency drops. Here the oil fog may penetrate the deep masses of hot compressed air with instantaneous effect in every direction from the spray nozzle without encountering chilled walls and instantaneous and very complete combustion results. In the compound engine the clearance volume is so large that the entire high-pressure piston displacement causes it to lose only a fraction of its pressure, thus bringing to the second stage, or low-pressure, both ample volume and pressure so that this piston (representing 6, 8 or even 10 times the area of the high-pressure) is driven to the end of its stroke with pressures still above the atmosphere.

Much Greater Expansion, Higher Efficiences

In this way the engine yields an expansion ratio based on gage pressures,

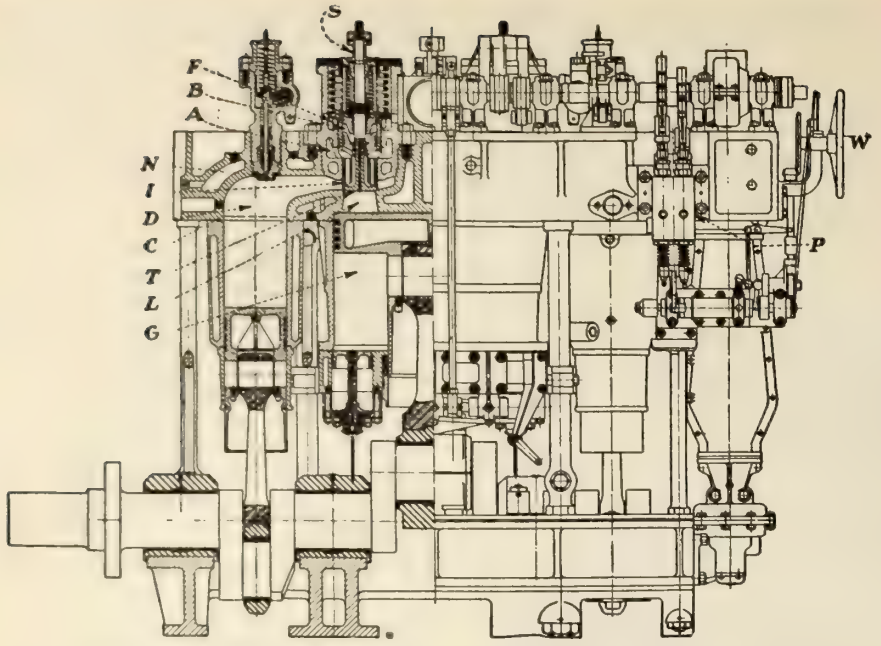


Fig. 9.—Section and elevation of compound oil engine showing construction.

which instead of being 3 or 4 to 1, as in the case of the automobile engine, or made as high as 120 to 1, yielding a higher return and greater efficiency from the fuel because of the lower temperature of the exhaust. The great volume in the combustion space furthermore allows this space, without distortion, to extend easily out over the top of the low-pressure piston, making a most direct connection therewith through short transfer port (see L, Fig. 9).

Fig. 3 shows the cycle card without fuel, taken from the high-pressure cylinder in a 10: 1 compound. The first-stage compression enters the cylinder at point A on its out stroke with the pressure about 113 lb., giving a power stroke indicated by line A. At point B the induction valve closes and on the in stroke the compression proper starts and rises on line B' to Diesel values at C. There being no fuel injection, the receding stroke brings the pressure down on practically the same line B' to point B (E in Figs. 5 and 6). Here the transfer valve opens and the gases pass on the in stroke to the low-pressure cylinder on line D. This is the out stroke of the low-pressure, the pressures sinking to a trifle below atmosphere before the final exhaust valve opens and continues open nearly during the entire next stroke of the low-pressure piston, which is, however, never shown on this high-pressure card but on the low-pressure card, Fig. 4.

Fig. 4 is the air-pump card representing the first stage of the compressor which delivers air to a small receiver, from which air is delivered during the induction stroke, on line A' of Fig. 3, which, it will be observed, is a power stroke with a high mean effective pressure, thus recovering some of the power of the pump.

Fig. 5 is the same as Fig. 3, except that fuel has been injected, and shows the regular slow Diesel burning common to all early cards of these compound engines, where from point C a perfectly level line is often drawn to point C" which marks the point of "cut-off." The gases then expand on line C" to point E, where the transfer valve opens and the gases continue to do work on a large area of the low-pressure piston, indicated by line D. The exhaust valve opens with pressures only slightly above atmosphere at point D'. The ordinary slow Diesel burning has the objection of lower efficiencies and allowing the heat to be added to the gases out nearer the exhaust end of the stroke.

Utilizing the Detonation of Fuels

Through a research extending over a year and a half or more, conditions were discovered by means of which "detonation" of the fuels may invariably be secured. This extends to a large variety, including of course the heavy fuels. While automotive engineers have adopted extreme measures, even lowering compression, "doping" fuels, etc., etc., in order to avoid the detonation, we have been working in the opposite direction. We have found that the thermodynamic efficiency is higher in case of high detonation diagrams than with low. Our work has been toward realizing these high efficiencies by developing instead of suppressing this high-intensity combustion. We have therefore sought to harness and utilize to the full the detonation phenomenon for the reasons and with the results outlined herein.

Fig. 6 is a typical card taken under the same conditions and the same engine as Figs. 3 and 5, exhibiting "detonation" and showing the quick burning, piling the heat up at the beginning of the stroke and as far away as possible from the exhaust end, giving also a very much truer Carnot-cycle card. All recent running of the compound engines has been in accordance with this card. One of the achievements of high-intensity combustion is better thermal efficiency and a still further reduction in the exhaust temperatures. The engine with this type of card is lifted from the old constant-pressure to the superior con-

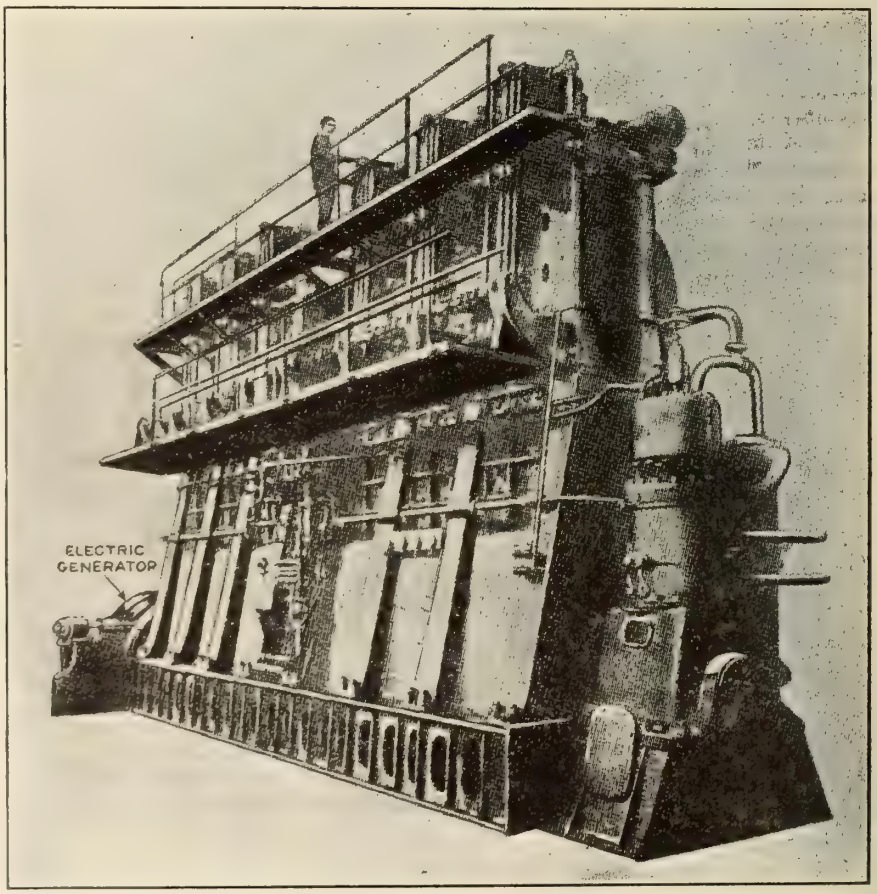


Fig. 10.—Standard type marine Diesel.

stant-volume performance which frees the compound from all speed limitations. The detonation characteristics, e.g., the vertical rise on the diagram, persist even at very high speeds. This card also insures operation at lower fractional powers without indication of carbon deposits.

Fig. 7 is given as showing the range of control of the peak and shape of the card at will under the same operating conditions and with the same spray nozzle.

Elimination of Losses in Transfer

In early attempts at compounding, principally layouts, it was found that prohibtive losses would occur in the transfer, due to the falling pressures while filling the low-pressure clearances. A complete solution of this is found in a special adaptation of the process of "cushioning"—closing the exhaust valve at a predetermined point before the outgases and cushioning them up to the transfer pressure so the transfer valve opens under conditions of equal pressure on each side. There are practically no losses sustained in cushioning; the power of compression is returned very completely on expansion. The additional advantage is secured of preventing all erosion due to high velocities of the hot gases over the transfer seats. These seats are amply jacketed and are found to remain smooth, bright and perfectly sealed over long periods. It is incidentally found that in cushioning, the adiabatic compression of the hot gases brings with it an equality of temperatures as well as pressures, so there is neither loss in pressure nor temperature at this critical point of transfer and the efficiencies are carried at high values throughout the cycle.

Fig. 8 shows the low-pressure card, indicating the same power pressure line D as Figs. 3, 5 and 6. On this in stroke the exhaust valve opens at D′ and closes again at point G on the out stroke, giving rise to the cushioning curve H, terminating at the same pressure and really the same temperature as at E in the high-pressure cylinder.

The Transfer-Valve Problem

The point X in Fig. 2 will be recognized as being the same as point B in Fig. 3 and point E in Figs. 5 and 6. The transfer valve considered as an exhaust valve is here called upon to handle much hotter gases than ever heretofore. It must be remembered, however, that compression in the compound is by the modern two-stage method. Air is admitted to the combustion chamber under comparatively high pressure and although it is warm, yet with each atmosphere of pressure its cooling powers are doubled. Air at 100 lb. thus has seven times the cooling power of atmospheric air, seven times the weight and seven times the molecules in contact for cooling. In forcing the high-pressure piston down on pressure line A′ in the above figures, air must pass some port in entering. Now, as a matter of fact, this port is in line with the transfer port and the induction valve itself rides on the back of the transfer valve in the form of a hollow sleeve I (Fig. 9) seated directly on the top of the transfer valve T. The back of the transfer valve is provided with greatly enlarged radiating and cooling surfaces presented to this cooling air and powerful convection currents are constantly acting when sealed. Moreover, this air when entering is at high velocity and gushes down through and bathes the deeply serrated surfaces of the back of the transfer valve, licking up the heat very completely in its inward rush.

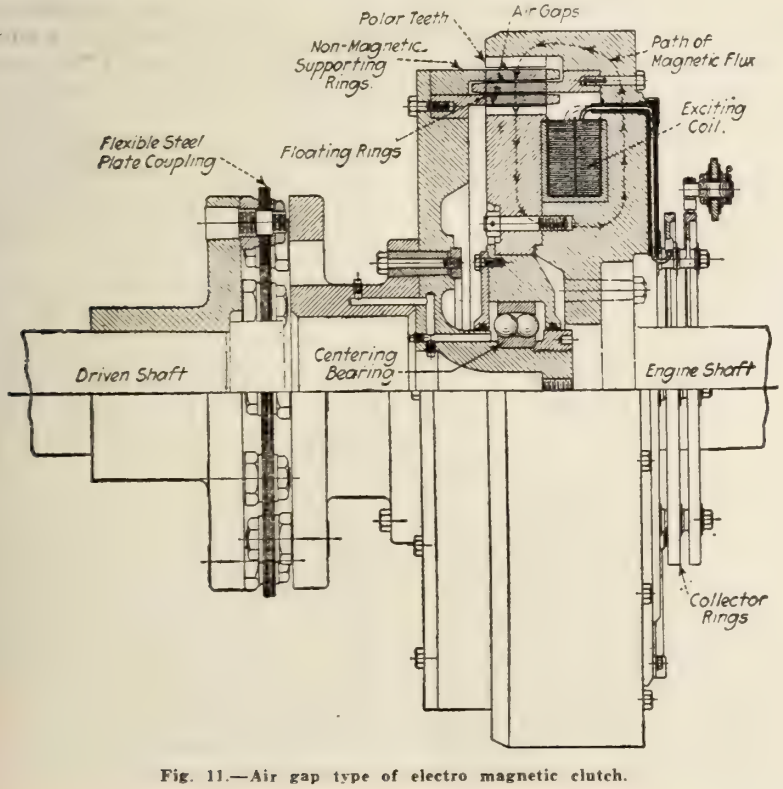


Fig. 11.—Air gap type of electro magnetic clutch.

Now in following out the cycle, it will be noticed that this is the very step that follows directly on the heels of the transfer of the hot gases (D, Fig. 3) and continues throughout the next quarter cycle (see A′ Fig. 3) and through the entire descent of the high-pressure piston, which in this way delivers a real power stroke to the crank with mean effectives in some instances greater than the mean effective pressures of the ordinary Diesel, thus returning some of the power taken to drive the supercharger or first-stage pump. If the transfer valve is intensely heated on its under surface (see T, Fig. 9) and is then instantly intensely cooled on a surface five times as great, it will certainly strike and maintain a heat balance which in practice is found to be extremely low. only about one-half the temperature of the Liberty valves, nowhere nearly approaching red heat nor the temperature of normal Diesel exhaust valves under load conditions.

Again, the heat in these gases absorbed from the hot valve is useful inasmuch as it is the auto-ignition temperatures as well as pressures that are required at the end of the compression curve B′ Here a useful heat transfer and pure regenerative process is carried out. The seats give no trouble because they are backed by the ample water jackets and, in fact, the whole transfer valve gear operates continuously and successfully and is found to be in perfect condition after hundreds and even thousands of hours of operation.

How Lightness is Obtained in the Compound Engine

The question often asked is, to just what is due the smallness and lightness of the compound engine? It is this: In the four-cycle Diesel we have the tonnage of metal due to the presence of high pressures operating at a ridiculously low material efficiency because these high pressures persist only about 2½ per cent. of the total time. The Diesel card rises abruptly and immediately falls. All the rest of the time, over 95 per cent., either low pressures or no pressures at all are present, whereas in the compound the pressures persist and we are dealing with great blocks of power, as can be seen from the power curve C″. Although the pressures are not materially higher than in Diesel practice, they are made to persist practically clear across the card, producing a very large gross mean effective. This is instantly followed by another line clear across the card, again producing another large gross mean effective in the low-pressure cylinder when referred to the high-pressure area, all from a single fuel injection. Instead of 60 to 70 lb. net mean effective to the crank, delivering its power through a few degrees only of one stroke in four, in the compound we have two net mean effectives, each of 300 or 400 lb. sq. in., succeeding each other and covering two strokes out of the four from a single fuel injection, giving very much better crank-effort distribution for power purposes. The

point of paramount interest is that these two large blocks of power are secured not by any material increase of pressures, but by using large quantities of power gases, and "hanging on" to the pressures we have in those gases throughout practically two complete strokes, clear across the card twice, thus abstracting much more of the power they contain before exhausting. Suppose these to be 330 lb. per sq. in. each. Added they make 660, which is easily ten times 62 lb., a net mean effective not infrequently met with in ordinary Diesels. In an engine of simple construction giving ten times the net mean effective to its crankshaft and well distributed, there should be no good reason why it should weigh more than one-tenth the weight of the present Diesel.

The power gases work in the Diesel about 120 deg. of arc and in the compound 315 deg., or 2.6 times as long; or, considering the points of "cut-off" in each, the true expansion curve is 3-1/3 times as long, which accounts for its large mean effectives and higher economies.

Proper Ratio for Compounds

As to the proper ratio for compounds, engine of 10: 1 ratio of low-pressure to high-pressure cylinder areas, also 8: 1 and 6: 1 have been made, operated and studied, the smaller ratios being at present considered more desirable. The weight factor does not change materially with changes in ratio in this region. The low-pressure piston operates two-cycle. The power distribution and the weight of the reciprocating parts both equalize best at about 6: 1. This makes a perfectly balanced unit, the end masses equaling and also moving oppositely to the central. The two full power impulses following each fuel injection are also about equal. Thus full four-cylinder performances are secured with only three cranks and two extra power impulses are delivered on the induction stroke (see line A', Fig. 3), making six power impulses for each cycle.

Another unusual advance should be noted, viz., complete reversibility and self air starting are secured without additional valves or cams over the simple, one-way engine without air starting, there being no difference in this regard. Again comparing the full-reversing, air-starting compound unit with a similar four-cylinder Diesel of any prominent make, delivering the same number of primary power impulses to the crank, the latter has 16 valves and 32 cams. The former operates the same cycle with two extra power impulses over the Diesel with 5 cams driving 7 valves.

Doing away with the three-stage air injection pump, its intercoolers and general complexity is another important simplification. One United States builder stated recently that an excess of 11 per cent. of the entire power of the engine is absorbed for driving these pumps.

Marine Type of Compound Engine

Fig. 1 shows a 10 : 1 compound engine built for heavy duty. Although this is a small marine type with high-pressure cylinders 7 in. by 11 in. running at 400 r.p.m., yet the size of the crank-pitman end in the lower center of the engine reveals the ruggedness of these parts. The fuel pumps are also shown here and the connection to the governor. The camshaft is on a shelf at the top of the engine to one side and is driven by skew gears. The electric generator forming the full load of this engine is shown in the background and one of the transfer valves with its bonnet cover stands on comparatively small size of the engine, although in the foreground, is notable and stands out in marked contrast with the engine of Fig 10, the product of the largest Diesel builder. This is the standard marine engine for some seventy ships. The electric generator forming the full load of this engine (so marked) is also in the background, as in Fig. 1. The generators in the two cases of course being standard, give an unusually excellent basis of comparison. The compound works at a piston speed of about 700 feet per minute and its generator would be still smaller in comparison, should it be worked at the piston speed of about 900 feet per minute of the large engine. Incidentally, in the foreground of Fig. 10 there is also an excellent illustration of the three-stage, intercooled, high-compression air pump for spraying the fuel into the cylinders.

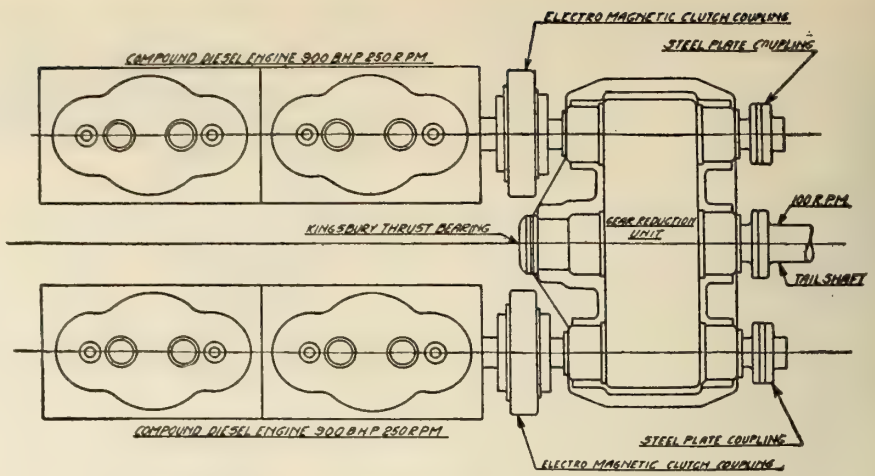


Fig. 12.—Plan of proposed installation of propelling machinery.

The large size and weight in the Diesels extends to all makes in somewhat different degrees. A line of Diesels made in the United States are reported to weigh 512 lb. per b.hp. The engine of Fig. 10 weighs 450 lb. per b.hp., while the compound in Fig. 1 weighs less than 30 lb. per b.hp.

Internal Construction of the Compound

Now as to the construction of the compound, Fig. 9 shows an elevation to the right of the center, and longitudinal section to the left, of the engine shown in Fig. 1. The two high-pressure or combustion pistons on their out stroke are at the ends and in the center the low-pressure at its extreme in stroke. The sturdy construction is indicated by the size of the crankshaft, about 50 per cent. larger than in any other combustion engine of which the author has knowledge, approaching, as it does, the bore of the combustion cylinders themselves. The fuel pumps P and the control and manipulating wheel W are shown in elevation to the right. To the left the large dome of clearance D, forming the combustion chamber of the compound, stands out in marked contrast to standard Diesel practice, which is shown by the little space C between the solid horizontal line at the base of the clearance and the dotted horizontal line just above. The dome is large and forms an upward extension of the combustion cylinder, extending also to the right in a large sweep surrounding the transfer valve T which seals the transfer port L. The sleeve-like induction valve I is shown seated on top of the transfer valve and is controlled by the cam-operated fork F. The transfer valve and sleeve are lifted by a fork not shown, located in thimble S near the top of the stem. The first-stage annular compression pump G surrounding the trunk piston below the low-pressure piston proper, delivers its air to a small receiver, which in turn discharges to the cored port A surrounding the induction sleeve I, the cooling action of which has been described. The little balancing cylinder B sustains a permanent connection with the low-pressure cylinder. The solid-fuel injection valve and nozzle N are placed approximately over the center of gravity of the large masses of air in the clearance dome D.

The comparison with the large dome constituting the clearance and combustion space in this compound with the small distance between the solid horizontal line at the base of the combustion space in Fig. 9 and the dotted line indicating the combustion space C in the normal Diesel, is simple to make and is significant.

It is understood that the two high-pressure cylinders are operating four-cycle, one 360 deg. back of the other, discharging alternately into the low-pressure, which therefore works two-cycle and delivers power on each down stroke. The cycle has been pointed out and the general operation will be apparent from this figure.

Field of Usefulness of the New Prime

To engineers versed in the problems of selecting and designing prime movers,

the advantages of the compound combustion engine are readily apparent. Its light weight for a given power with resulting low first cost and capital charge, the low costs for foundations, the high speeds with consequent low costs for connected generators, the small space required and the simplicity and economy of operation are important reasons for suggesting new fields for this prime mover, which has been proven of practical value in a long series of tests under working conditions. The compound engine is especially adapted for use for auxiliary or stand-by service in water-power stations or for carrying the peak loads in central stations where installations are as large as 21,000 kva. have been contemplated. The important considerations are quick starting, non-deterioration of fuel reserve and flexibility of required fuel, amounting to almost complete independence of fuel quality. Other uses for the compound which readily suggest themselves are city water works and irrigation projects, either directly or by electrical distribution.

The possibilities of the compound-Diesel-electric locomotive should not be overlooked, as it presents all the well-recognized advantages of electric traction. At the same time it represents a component part of the central power station, with the advantage over the latter that it operates at the highest thermal efficiencies known—nearly three times the efficiency of even a very large power plant, i.e., three times the tractive effort is delivered to the rail from every pound of fuel burned. Also the capital charges for main feeders, substations, bonded rails and shunted switches and frogs, and the third rail or elaborate overhead construction are eliminated. The tracks are used exactly as they now stand.

Application to Ship Propulsion

We now come to the greatest present employment of oil engines, namely, their substitution for steam in ship propulsion. The advantages of motorships are rapidly being recognized, and they are now being built in practically every maritime country more rapidly than ever before. There were building last year 454,502 tons of Diesel-driven ships, or over 7 percent. of the world's total under construction. In the light of the past ten years' experience the Diesel engine has proved an efficient, reliable and thoroughly seaworthy prime mover, suitable for a large proportion of the total sea-borne tonnage.

Novel Electromagnetic Clutch Affords Elastic Drive

In connection with the development of the compound engine for marine purposes, and in order to provide any Diesel type of engine with speed flexibility equaling the reciprocating steam engine, there has been developed an electromagnetic clutch operating on an entirely new principle.

This new type of clutch transmits power entirely through air gaps and has no mechanical contact whatever between the driver and driven, eliminating wear and deterioration. It is capable of remote control and can be operated at any speed from zero to full engine speed; the torque may be varied at will from maximum to minimum. The power required to operate the clutch at full load is but a small fraction of one per cent. of the power transmitted. In one instance 525 hp. required 256 watts, or 0.065 per cent of the power transmitted. An outstanding feature of this clutch is that on direct drive or full speed it is magnetically locked, which insures perfect synchronism and no slip with an extreme increase in pull-out torque. At this and all times, in fact, the transmission has the "velvet touch" of an air drive and insures complete torque-wise isolation of the mass moments lying on the two sides of the clutch. As seen in Fig. 11 the clutch forms a part of even a small-sized flywheel of either a Diesel or compound with little, if any, alteration of its mass moment.

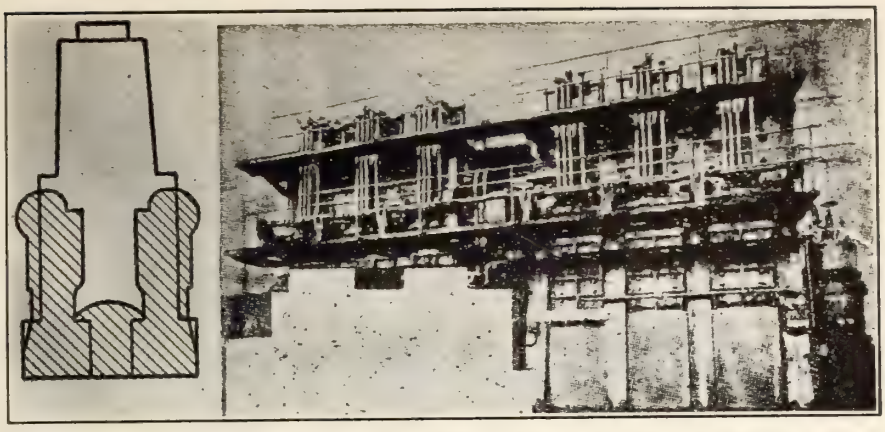


Fig. 13.—Comparison between compound divided unit geared drive and standard Diesel engine delivering to tail shaft and same power and speed.

The clutch is characterized by two kinds of torque operating by opposite phenomena; the greater the differential or relative velocity between the driver and driven parts, the greater the torque available for starting and for bringing up to synchronism. This phenomenon also provides for slipping and continuous operation at all fractional speeds by means of the loaded secondary effect acting as an induction motor.

The air-gap clutch drives through magnetic flux comprising four ring elements, two of which are driving and two of which are driven. The flywheel proper accommodates an exciting coil producing the magnetic flux. At all fractional speeds or while this clutch is slipping, this magneto induction generates large currents in the driven elements which are now acting as short-circuited secondaries, producing heavy drag torques under perfect control by varying the amount of coil excitation. However, when the speed comes up in the vicinity of synchronism, locking occurs.

Proposed Installation of Propelling Machinery

Fig. 12 shows in plan view a proposed installation of the propelling machinery, securing the advantage to both engine and tail shaft of entire freedom of each to run at its own best speed. A propellor for a given ship has a speed at which it gives its most efficient performance; likewise a combustion engine can be built most economically and to give its best performance for a given size if the designer is given entire freedom to choose the best engine speed, a condition which is extremely desirable.

With this clutch and the engine combination shown in Fig. 1 several very important advantages are secured:

(a) There are available on a single propellor all the advantages and flexibility of a multiple engine equipment, where one engine may be shut down and completely disconnected for inspection, valve grinding, etc., and yet the ship be going forward at three-quarters its normal speed.

(b) Complete flexibility of the electric drive without the expense, weight and space of the electric generators and motors and the cumbersome electric control equipment for handling the heavy currents in maneuvering, and the double losses of generators and motors which are of substantial amount and a constant drag on plant and fuel economy.

(c) The simplest form of gear drive may be employed because the magnetic clutch allows the pinion to be a complete "floater." The pinion may thus accommodate itself to any part of precision and all sorts of idosyncrasies of the main gear and teeth without shock. Any irregularities existing have to deal only with the small masses of the pinion itself and its sub shaft, being completely isolated from the large mass moments of the engine.

(d) The well-known irregularities in torque of any reciprocating engine and circumferential oscillation are entirely smoothed out by the air gap in the clutch and are not permitted to reach the pinion; its specific tooth operation is thus completely safeguarded. The crash and general irregularities of the engine torques thus never reach the pinion and therefore can have no effect on the complete smoothness of its performance.

(e) The torque, being under complete control, can be lowered so as to safe-

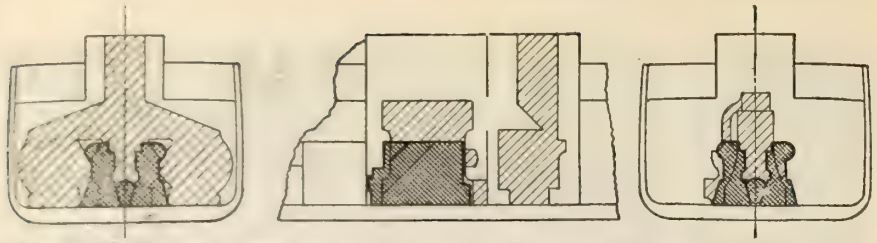


Fig. 14.—Comparison between reciprocating steam plant and geared compound Diesel engine.

guard the equipment against overloading, especially when sailing in obstructed harbors, near derelicts, and where floating obstacles are likely to be encountered by the propeller blades, thus providing an important emergency disconnecting gear breaking away from the large engine masses and allowing the propeller to "stop in its tracks" through the self-interruptibility of the magnetic clutch when reduced to fractional underload condition. In this way many disasters to the propelling machinery and interruptions to the service may be avoided.

(f) Nearly all revolving machinery is subject to periods, sometimes running into severe "criticals." These criticals always develop from the irregularities in torque of the mass moments within the engine pitted against outside mass moments aft. This can occur only when these are solidly coupled with each other, but if instead they are isolated, as by the cushion or air gap of a magnetic clutch of proper design, these troublesome criticals with their excessive stresses are completely suppressed and can never develop.

(g) The combustion engine is reversible and runs equally well in either direction. The magnetic clutch solves completely all maneuvering problems, and in this way stands out in bold contrast to the difficult maneuvering and reversing conditions introduced by the non-reversible turbine.

As seen in Fig. 12, a Kingsbury or equivalent thrust bearing may be located forward of the main gear. The pinions flanking the gear on either side are not necessarily diametrically disposed. This gives an excellent distribution of the machinery, compact engine-room arrangement, and ample space for the small oil-engine generating sets for the ship, which incidentally also supply the clutches with the very trifling amount of energy and any other auxiliaries outboard of the engines. The engines are completely reversing and self-air starting, and either engine may be completely isolated at will. When either engine is running, the other may be gradually or quickly started up by means of the clutch instead of by air, if desired. The engines under this arrangement run with extreme smoothness and under complete control. In one instance the clutch succeeded in suppressing entirely a very serious "critical" which occurred in a 700-hp. submarine type Diesel near the normal running speed.

Saving in Weight and Space over Diesels

In Fig. 13 there is shown in side elevation to the left, and end elevation to the right, the comparison between the compound divided-unit geared drive delivering to the tail shaft the same power and speed as the standard Diesel unit of the largest manufacturer. The divided unit consists of two engines, each with four combustion cylinders, in two compound units. Note each of these engines gives the same turning moments and torque diagram as an eight-cylinder Diesel. In fact, with this divided unit we have eight combustion cylinders in the two engines with less than half of the cams, etc., of a six-cylinder Diesel, with all the advantages of two engines, including immunity from shutdown, possibility of inspection and other operating advantages which are well recognized. These two views serve graphically to give some idea of the saving in weight and space.

To aid in the comparison with the reciprocating steam engine, Fig. 14 has been developed, giving three views of the steam plant in shaded background. Against it there is outlined the standard compound, two-engine, geared magnetic-clutch arrangement for the identical horsepower and speed at the tail shaft.

ANNOUNCEMENT

Messrs. Edwardes Costello & Lowe have opened an office at 772 Bathurst Street, where they will carry on a general engineering business, including feed water treatment, combustion, boiler cleaning services, and general efficiency work.

COAL SAMPLING APPARATUS

Work on the development of new types of coal sampling apparatus is being done at the Washington, D. C., office of the Bureau of Mines, under the direction of O. P. Hood, chief mechanical engineer. The practicability of coal inspection on a large scale depends upon the development of sampling devices which can obtain a true representative sample with the least possible interference with transportation methods. This means the development of apparatus somewhat comparable with apparatus used for loading and unloading coal. A machine has been developed which will drill a six-inch hole vertically through coal carried in a car and abstract the cuttings. Complete detailed plans have been made for a single sampler adapted to take sample from truck loads at the Government Fuel Yard. General plans have also been developed for a multiple sampler adapted to take samples from open top cars in a railroad train without distributing the train or the unloading coal. Only the reduced laboratory sample is to be taken from the sampler.

* * * *

CLEANING COAL.

The past work on the float-and-sink method of cleaning coal, conducted at the Northwest Experiment Station of the Bureau of Mines, Seattle, Wash., has resulted in the development of an efficient large-sized machine for making these tests. This machine has been used in studying the washability of coal, in controlling the washing operation, and for measuring the efficiency of the individual coal-washing machines. In using this machine for future studies, there is a possibility that it will be developed even to a more efficient point. This machine, however, does not give satisfactory results using fine sizes of coal. Work is being planned in which the limitations of the float-and-sink method on fine sizes will be determined. It is hoped that the float-and-sink machine can be adapted to washery control in the coal washeries of the State of Washington.

* * * *

FUSIBILITY OF ASH.

A thorough survey of the fusibility of coal ash from various coals of the United States has been completed by the Bureau of Mines and the data tabulated for publication as a bureau bulletin. The method for fusibility of coal ash as developed by the bureau has been adopted as a tentative standard method by the American Society for Testing Materials. An alternate rapid method known as the micro-meldometer method has been proposed. The bureau has assembled the equipment for this alternate method and in co-operation with a number of other laboratories a series of tests comparing the two methods is being made. In co-operation with the fuel section of the bureau, it is proposed to investigate the relation of laboratory fusibility tests to clinker formation in burning coal under actual operating conditions.

* * * *

TRENT PROCESS FOR CLEANING COAL

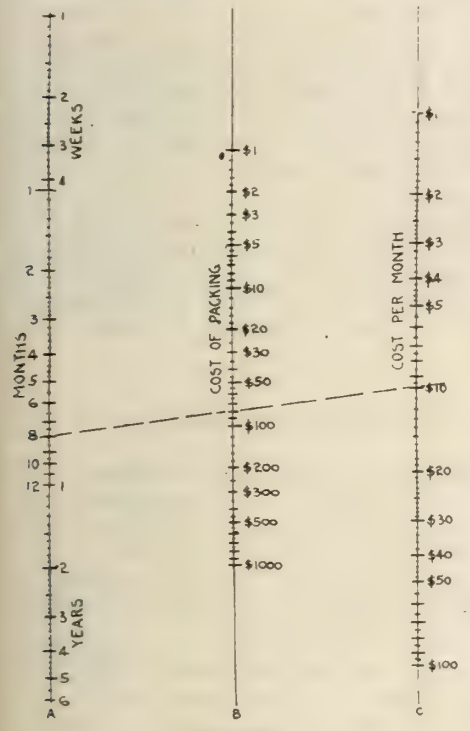
The efficiency of the Trent process in cleaning coal has been determined by the Bureau of Mines for typical coals of the United States. The point of superiority of the Trent process over ordinary washing methods is the high combustible recovery obtained, in some cases as high as 99 per cent. Low-grade subbituminous coals and lignites do not respond readily to treatment by the process. The process is not efficient in removing sulphur present as purite in the bituminous coals; with anthracite coals, sulphur removal is good. The relation between fineness of grinding and ash separation has been determined on typical coals pulverized to sizes as small as 10 microns, (.10 mm.)

HANDY CHART FOR COMPARING COSTS

Copyright by W. F. Schaphorst

This chart will be found handy for determining the cost per month of the various materials used in and about the engine room. It is a good thing to keep tab on supplies purchased so as to know when bought and when replaced. Then by dividing by the number of weeks, months or years of service, the cost per month is found and the engineer can decide whether or not to purchase the same thing again.

For example. Let us assume that a certain engineer bought what he thought was a good trade of packing. He packed his pumps with it, and found the total cost to be $80. After eight months the packing was worn out and had to be replaced again. What was the cost per month? That is an easy one and can be done mentally, but just to show how the chart works, I have selected an easy one for a starter. The dotted line drawn across the chart shows that you merely have to lay a straight edge across connecting the $80 (column B) and the 8 (column A) and the extension of the line



Cost Chart

cuts column C at $10. In other words the packing costs $10 per month.

The engineer now sees a given packing advertised which, it is claimed, will last much longer, but its first cost is more. He might naturally say to himself without figuring at all, "That costs too much. I can't afford it. Guess I had better use the same old packing." However, the engineer leisurely lays a straightedge across connecting the claimed length of life (two and one-half years) with the estimated cost ($200) and he finds to his surprise that such a packing would cost him a trifle over $6.50 per month. He rubs his eyes. He tries again. He thinks there must be something wrong with the chart, and "dopes it out" longhand only to find that the chart, after all, is pretty accurate. As a result he purchases the packing which costs more at first, but considerably less in the long run. It is evident, therefore, that the chart is a valuable one and it would be well to keep it in a handy place whenever looking through advertisements or whenever purchasing supplies.

The chart applies not alone to packing, but to anything that wears out in a short time. Gaskets, cylinder oil, belt treatment, belts, valves, grate bars, etc., all come under this head. Even though the exact cost may not be given in column B it is a simple matter to shift the decimal points in such a way that the correct answer will be obtained in column C. Thus if you bought only three cents worth of waste, and if it lasted four weeks, you would connect the four (column A) with the $3 (column B) and the line cut through the $3.50 in column C. It is evident that in writing three cents with a dollar sign in front of it, it becomes $.03. The decimal point is, therefore, shifted two places to the left in column B, and at the same time the decimal point must be shifted the same number of places to the left in column C, which gives us 3½ cents per month as the answer. The range of the chart, it will be noted, is wide enough to care for every ordinary case of supply purchasing.

W. F. Schaphorst.

New Air-Cooled Motor Cycle Engine

The design of engines for motor cycles presents many problems of interest to the engineer and of great importance to the manufacturer. Simplicity, robustness, reliability, smoothness of running, efficiency, and many other qualities have to be combined in a machine which must in the end be cheap. Mainly because of this last factor, many refinements employed in the motor car engine cannot be adopted in the motor cycle engine. Such conditions offer a clear stimulus to the skilful designer, and a new type of engine produced by a British firm marks a considerable advance towards the ideal. It is an air-cooled motor-cycle engine with sleeve values. Hitherto the use of the sleeve valve in any type of motor car engine has been looked at a little askance, owing to expected trouble with lubrication and cooling. These troubles are not encountered in the numerous examples of automobiles fitted with sleeve-valve engines; and their success has led this firm to adopt the sleeve-valve in an air-cooled engine—the first time this combination has ever been attempted. One great advantage of the sleeve valve is its silent action; the public will be grateful for any reduction in the noise made by motor cycles.

PHYSICAL TESTING OF COKE

The physical characteristics of coke is a matter of great importance to the blast furnace and foundry men. Tentative definitions of terms relating to coke have been formulated by the Bureau of Mines and submitted to the American Society for Testing Materials. Data are being assembled as to the methods in general use in making "shatter" and "hardness" tests on coke. The Bureau of Mines realizes that if the results of such empirical tests are to the best advantage they must be standardized in order that the results obtained be comparable. It is proposed to get as much information together as possible as to the methods of conducting these tests and from these data tentative methods will be submitted to the American Society for Testing Materials for the making of "shatter" and "hardness" tests on coke.

SPECIFIC GRAVITY STUDIES OF COALS

Preliminary to undertaking a detailed investigation of the different coal washeries in the State of Washington, a study has been made by the Bureau of Mines of the specific gravity and ash content of many Washington coals and their associated impurities. Results of this study indicate that both the coal and the impurities as they exist in the bed are saturated with moisture. A technical paper describing this study is now in preparation.

ORIGIN AND CHEMISTRY OF COALS AND SHALES

An extensive investigation is being conducted by the Bureau of Mines regarding the origin, composition and chemistry of coals, cannel coals and boghead coals. The coals from various beds and localities are examined microscopically. Thin sections are cut and examined at all magnifications; the constituents forming coal are examined and certain characters are recorded photographically. Coals may thus be studied concerning their nature, quality and various characteristics. The kinds, relative amounts and nature of the various constituents are studied and co-related with their distillation products and other qualities and characteristics shown in relation to their economic uses, such as coking, gas production, steaming, etc. Oil shales and cannel slates are also being studied by the Bureau of Mines as to their origin, composition and chemistry. Thin sections are cut and studied under the misroscope and characters recorded photographically. The mineral matter is removed by means of acids and the remaining organic matter examined and compared with thin sections. The organic matter is burned out at low temperatures and the remaining mineral matter also examined and compared with thin sections. The kinds, nature and relative amounts of the various constituents are thus studied and co-related with the kinds, nature and relative amounts of distillation products.

The report of the investigation made by the Bureau of Mines at the Pittsburgh Station, relating to the value of coke, anthracite and bituminous coal for the generation of steam in the low pressure cast iron boiler, is being prepared for publication at a later date.

Member of the Audit Bureau of Circulation

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TORONTO, MARCH 5.

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The Board's Circular Letter

IN ANOTHER part of this issue we reprint a letter that has been sent to the chairman of the Board of Stationary Engineers, to manufacturers and those who own plants coming under the jurisdiction of the department.

It is noteworthy that a number of our readers have sent this letter to us, with favorable comment, and a request to publish it, which we had already decided to do, feeling that it should be seen by as many engineers as possible.

The spirit of the letter shows a nice appreciation of the view point of both engineer and employer, their claims on each other. It points out that the way for the engineer to make himself more valuable is for him to increase his education and knowledge. It shows that the Board of Examiners are anxious to give the man who is still in the lower grades a chance, and are making the examination for the lower grade certificate of a practical nature. A feature that should be re-assuring to everyone is the distinct statement that there are no "catch" questions. Mr. Brown is to be congratulated on his action in sending this letter out, and the appreciation of the possibilities of his position that it shows. The engineers are also to be congratulated on the fact that it is quite evident that in the chairman of the Board of Engineers they have a fair minded official who is anxious to do the right thing by all parties concerned.

It remains now for employers in general to help on the good cause by making the engineer's position one that will attract the best type of man, and make it worth his while to spend his time in study to make himself a better man. When all is said, the person who derives the most benefit from the better education of engineers is the owner of the plant, and he should recognize this fact, and act accordingly.

* * * *

Another Step Forward

THE DESCRIPTION of the compound internal combustion engine in this issue of "Power House," should be read eagerly by the engineering profession. The development of this engine marks another step forward in the eternal endeavor of man to utilize the forces of nature with a greater degree of efficiency.

The utilization of the energy remaining in the gases in the cylinder of the internal combustion engine, at the moment exhaust ordinarily takes place, enables great economies to be effected, not only in fuel, but in space and weight of the engine. In fact, it is stated that a weight approximating five lb. per horse power is attainable. The inventor of the engine points plane engine, that is, making it possible for the heavy oil engine to be used for aeroplanes, eliminating the fire risk from the gasoline tank.

While this particular engine has been developed for marine use the principle lends itself to stationary application just as readily.

Experimental work is being carried on in England with the Still engine, in which the hot exhaust gases from the internal combustion engine cylinder are passed through a small boiler or regenerator and the steam obtained is used on the under side of the engine piston. The device is not so simple as this brief description would indicate, but the thermal efficiency achieved has been very high. In this engine the water cooling effect of the jacket is increased by allowing the water to be evaporated, thus utilizing the latent heat property of the jacket water. At thermal efficiency of 39.2 per cent. has been achieved with this engine.

The time must come, and perhaps it will come more speedily than some of us think, when the practice of burning coal in its raw state under boilers for steam generation will cease altogether. It is universally known to be highly wasteful, not only in the loss of heat, but the loss of valuable by-products, which are carried away with each pound of coal burnt in boiler furnaces.

The continual research and experiment that is going on, and the startling developments which come as the result of these investigations, keep the engineer keenly on the alert, so that he may be abreast of these developments, and ready to seize the opportunities that may be presented to him by them.

* * * *

Pay as Promptly as Possible

FINANCING is not an easy matter just at present. In fact, some firms frankly admit that the reason they cannot pay their bills as promptly as they would like to, is because they in turn cannot collect from their customers. Unfortunately some who do not really need to do so, are taking advantage of the situation, and are issuing notes, and retarding the payment of same as long as possible.

When any number of firms start this practice, it is not long before the majority of the business community is following suit, financing on long terms instead of prompt acceptances. This is bad business, and while every leniency necessary should be extended to worthy institutions, who may be rather pressed for ready cash at the moment, still, on the other hand, no financially able firm should hold back payment when they are able to pay their way. Let a few of this type start the ball rolling, and it would not be long before collections would become easier all around.

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OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

BOILER DIMENSIONS AND EVAPORATION

Question:—Please give the principal dimensions of a 60 inch by 20 feet long h.r.t. boiler. What rate must water be evaporated per horse power? If a boiler evaporates 2987 lbs. of water from 100 degrees into steam at a pressure of 100 lb. gauge per hour, what is the equivalent evaporation from and at 212 degrees? G. K.

Answer:—To answer the first question it is necessary to make some assumptions. In the first place no pressure is given for the boiler, and secondly, twenty feet would be a most unusual length for a boiler of this diameter. It would more likely be 16 feet or perhaps 18 feet. We take it that the questioner requires thickness of plates, number of tubes, etc. If we assume to begin with that the boiler is to work at 100 lbs. per square inch, and that the longitudinal seam is to be of at least 75 per cent., we can get the thickness of shell and heads, area of segment, number of stays. The formula for working pressure is

$$W.P. = \frac{T.S. \times \% \times 2t}{F \times D}$$

where T.S. = Tensile Strength of material
% = Least % of longitudinal seam
t = thickness
F = Factor of safety
D = Diameter of boiler in inches.

Allowing that the tensile strength of the material will be 60,000 lbs. per square inch, and that the boiler has a factor of safety of 4.5, we can from the above formula find the thickness of shell.

$$t = \frac{W.P. \times F \times D}{2 \times T.S. \times \%}$$

substituting figures for the letters in the above

$$t = \frac{100 \times 4.5 \times 60}{2 \times 60000 \times .75} = .3$$

This gives us a thickness of shell plate of .3 inch. Now as plates are made in thicknesses varying by sixteenths of an inch we must see what is the closest dimension in 1/16ths corresponding to .3. Then we have .3/.0625, which is 5/16ths.

We have then 5/16ths for the shell, and allowing 1/16th more for the head we shall have 3/8th heads. Allowing one third of the volume of the boiler for steam space that gives us a height of 24 inches for the segment, assuming that there will always be four inches of water over the top of tubes. A boiler this size would be approximately 75 horsepower, which gives a heating surface of 1125 square feet. If the shell is 16 feet long then the heating surface of shell will be

2.5 x 3.1416 x 16=125.6 square feet.

This leaves approximately 100 square feet to be supplied by the tubes. The heating surface of one tube is the outside diameter x 3.1416, divided by 12, and multiplied by the length, so if we take a three inch tube we have

$$\frac{3 \times 3 .1416 \times 16}{12}$$

12.5 square feet in one tube.

This would give a total of 80 tubes. Of course in laying out the tube sheet for actual construction there might have to be some modification of this, but these would be the dimensions which would determine the design. The area of segment can be found after the actual tube sheet is laid out by the rule

$$\frac{4x \; hxh \; x\sqrt{\; d}}{3 \qquad h} .608 = \text{area},$$

making the usual allowances for tube and shell support.

After the area of segment is determined the number of stays and their diameter can be found. The total load on the segment will be the pressure x area of segment. This divided by the stress per square inch allowed on the stay material will give the total sectional area of all the stays. The number of stays can be determined by the minimum pitch which will allow for free movement in the boiler, and this pitch divided into the total area to be supported will give the number of stays. Knowing the number of stays and the total sectional area of stay required, the area of one stay can be found by dividing the number of stays into the total sectional area. The joint on the longitudinal seam would be a double riveted lap to fulfil the 75 per cent. that we assumed. If a triple riveted lap or a double riveted butt joint is used they can be designed to meet the requirement of a minimum ratio of 75 per cent. to the solid plate.

A study of the issues of Power House for the latter part of 1920 will give the reader full particulars of this matter. We have not space here to go fully into this.

A boiler horsepower is the evaporation of 34½ lbs. water per hour from and at 212 degrees, that is from water at 212 degrees into steam at 212 degrees. Steam at 100 lbs. gauge has a temperature of 337 degrees, and with feed water at 100 degrees this gives a quantity of 227 B.T.U. per lb. to raise the water to the same temperature as the steam. The latent heat of steam at 100 lbs. gauge is 876 B.T.U. so that we have a total quantity of heat of 876 plus 227 or 1103 B.T.U. required per lb. steam. As the quantity of heat required from and at 212 is only 966, the factor of evaporation would be 1103/966, which is 1.14. Multiplying 2987 x 1.14 we get 3405.18 lbs. as the equivalent evaporation from and at 212.

PLANT RATING AND BOILER FEEDING

Question.—In the case of a battery of two boilers connected up together, each carrying 100 lbs pressure, what would be the rating of the plant, two hundred or one hundred horsepower? R. I.

Answer.—The rating of a boiler for the purposes of the Ontario Act is independent of the pressure carried, but is calculated on the heating surface. The rating then will be proportional to the total heating surface of the boilers in the plant, and two boilers each rated at 100 horsepower would be a two hundred horsepower plant.

Question:—If a battery of three boilers is fed by a feed pump and one boiler is cut out of the line, and allowed to drop to 50 lbs pressure, would there be any harm in feeding it with the same feed pump that is feeding the other two boilers at 100 lbs pressure? Would the pressure be equalized if all three valves were opened at the same time? R. I.

Answer.—Opening all the checks to feed would not have the effect of equalizing the pressure on the boilers, the only result would be that all the water would be delivered to the boiler having the least pressure. If all the steam valves from the boilers to the pumps were opened the pressure would then be equalized, but on the feed lines the check valves would prevent the pressure from the 100 lb boilers blowing back to the 50 lb one, unless these checks were lacking. In feeding the low pressure boiler the steam valve on the pump would have to be checked or else the pump would be likely to run away, causing shock and perhaps damage to the pipes.

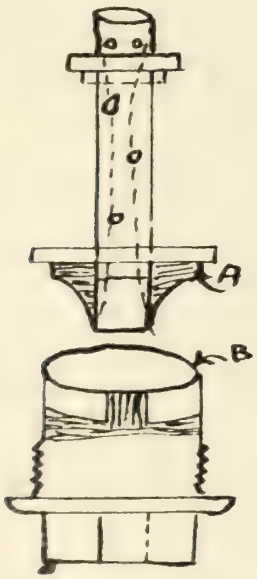
Continued on page 45

The Operators' Point of View

AN INJECTOR TROUBLE

The accompanying sketch of the jets of a ¼-inch injector will serve to explain the following:

The injector was supplying a 50-horsepower boiler, supplying steam to a Waterous engine, and never gave any trouble until recently, when it commenced overflowing considerably, and only feeding about half the water it picked up. There was no sediment in the feed pipe, and no apparent cause for the trouble.



Injector Jets

I took the jet apart and fitted a gasket about 3-16th thick in between the two at the flange A, and screwed them together again, after which there was no further trouble. I have since found that a gasket 1-16th thick will do the same.

This may be of interest to other engineers.

BOARD OF ENGINEERS

In sending out the copy of the amendments to the act passed at the last session of the legislature, the Board of Examiners are enclosing the following letter, to all manufacturers and owners of plants coming within the regulations. The letter is a statement of policy, and as such, should be of interest to the engineers as well as the owners.

Dear Sir.—In order that you may become familiar with the amendments made to the act respecting stationary and hoisting engineers at the last session of the Legislature, we are enclosing, herewith, a copy of the act. We particularly wish to draw your attention to the section dealing with the requirements demanded by the Board of the different classes of engineers.

The engineer believes that, owing to the responsibilities placed upon him, he should receive higher remuneration than the ordinary laborer, but we also believe that it is the duty of the engineer to fit himself for these responsibilities and put forth his best efforts to obtain the knowledge that will enable him to efficiently and safely perform his duties.

Ambition is the keynote to success and we believe that graded certificates will encourage the engineers to rise to the height of the profession. In their endeavor to reach this height they must constantly be in search of new knowledge which they will unconsciously apply in the daily discharge of their duties —thereby making themselves of greater benefit to their employers.

We endeavor to make the questions presented on the lower grade examinations papers of a thoroughly practical nature, dealing with the construction, care and operation of all apparatus found in the ordinary Ontario power house, with which every energetic engineer will be familiar. We are careful to avoid all catch questions.

It is our aim to encourage the engineers to become more observant of the different apparatus found in their own plants, and to study the articles which may be found in the many excellent books, magazines, and pamphlets now published on engineering work. We also advise that when possible he take advantage of the night school classes for engineers, nearly every large centre in Ontario having one or several of these classes.

We ask your co-operation and assistance, and we will at all times be pleased to have your suggestions and criticisms.

Yours very truly,
J. M. BROWN, Chairman.

BOILER PLATE FAILURE

By C. H. Watson

Power House readers may be interested in the particulars of a failure under hydraulic test which took place recently, on a boiler built in 1911 while under a hydrostatic test of 160 lbs. per square inch. The boiler is a horizontal return tube of 66 inches diameter by 16 feet long, with a shell 7/16th inches thick. The shell is made from two plates, the longitudinal seams being triple riveted lap joints. The working pressure allowed the boiler was 130 lbs. per square inch. Under the hydraulic test the second plate gave way along the edge of the rivet heads. The plate is eight feet long, and the split extended for a length of about six feet, to within about four inches of the back head. In the centre of the fracture it opened up about 3/16th inches, and revealed the fact that there was only about 1/32nd inch of the original plate left in one part extending about the length of four rivets. This crack could not be seen from the inside as the under plate covered it by about 5/8th inch. As far as the writer knows this is an unusual place for fracture.

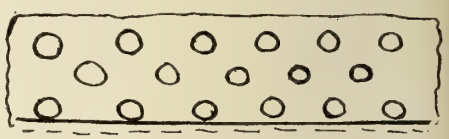


Plate Fractured under rivet heads where black line is drawn above dotted line.

The boiler appears to be in good condition otherwise.

Editor's Note.—There have been a good many instances of fractures of this kind taking place with lap joints, and for this reason this type of joint is looked on with great disfavor by a good many authorities.

NOTICE TO CORRESPONDENTS

Power House wishes to express thanks to those correspondents whose letters have arrived since last issue of Power House, on the question of the Dominion-wide Certificate. We believe that this correspondence has achieved its object, and have therefore terminated it. To those whose letters did not receive publication we would point out that it was not possible to publish all the letters received, through lack of space, but we endeavored to show as many viewpoints as possible.

Our columns will be open to anyone coming forward with a concrete suggestion as to how best to obtain action leading towards the establishment of this certificate, which seems to be approved of by the large majority of our correspondents.

The York Sandstone Bridge Co., East Toronto, Ont., is asking for prices on a horizontal tubular boiler.

C.A.S.E. Competition Questions and Answers

Question:—What is CO_2 and why is CO_2 percentage accepted as an indication of combustion conditions?

Answer.—CO_2 is the result of the perfect combustion of one part carbon and two parts of oxygen. CO_2 percentage is taken as an indication of perfect combustion condition because when carbon is burned on a grate there is an action taking place as follows:—The oxygen passing through the grates as air combines with the hot carbon in the proportion of two (2) of oxygen to one (1) of carbon forming carbon-dioxide, and as long as the air is sufficient this condition of chemical action is maintained. The combination or product of combustion is called CO_2. If the fire bed is too thick or has holes in it for the admission of excess air the combustion or result would not be perfect combustion and the product is called CO or carbon monoxide and this gas in excess indicates that the combustion is imperfect and the maixmum amount of heat has not been developed from the fuel.

* * * *

Question:—What is a CO_2 recorder, and describe the operation of at least one well-known make?

Answer:—A machine which automatically analyses the flue gases to give the percentage of carbon-dioxide, the chemical symbol of which is CO_2 from which fact the machine is known as a CO_2 Recorder. The Orsat consists of a combination of collector and three graduated glass tubes, containing various chemical solutions. Each tube contains an obsorbent solution; one to absorb CO_2; one for CO, and one for O. Each part has a small "U" shaped pipe attached and they are half-filled with their respective solutions; the CO_2 pipe has a solution of caustic potash and pyrogallic acid; the CO pipe has cuprous chloride in it, which is from copper oxide 25 grams and 500 c. c. of hydrochloric acid, and reduced by adding an equal volume of the acid mixture. Water well saturated with CO_2 is used for displacement but for very accurate work it is better to use brine water or mercury.

* * * *

Question:—(a) Explain why 21% CO_2 is the highest possible percentage in flue gas. (b) What are the component parts of flue gas.

Answer:—Because the air or draft is composed of 21 parts oxygen and 79 parts nitrogen, and as carbon will only combine with the oxygen therefore the amount taken from the air cannot exceed 21%, except where some artificial gas is introduced along with the air, as in the case of blast furnace gases.

(b) Oxygen ....Symbol	O
Nitrogen	N
Hydrogen	H
Carbon monoxide	CO
Carbon dioxide	CO_2
Sulphur	S

Question:—Why is it that 21% is not the most desirable? Give calculations proving this and supply if possible a simple formula to determine this point.

Answer:—One thing could be said and that is that there might be an excessive temperature accompanying 21% CO_2 and this would ruin the brickwork by over expansion, thus causing cracks, etc., besides excess stack or exit gas temperatures would indicate heat losses, offsetting the CO_2 indications.

* * * *

Question:—What percentage of excess air is present 8, 9, 12, and 15% CO_2?

Answer:—In dealing with the problem we have assumed that we are dealing with pure carbon and not ordinary coal.

$$\text{Formula:}\quad \frac{21-CO_2\%}{CO_2\%} \times 100 = \text{excess air}$$

$$8\%\ CO_2 = \frac{21-8}{8} \times 100 = 162\%$$

$$9\%\ CO_2 = \frac{21-9}{9} \times 100 = 133\%$$

$$12\%\ CO_2 = \frac{21-12}{12} \times 100 = 75\%$$

$$15\%\ CO_2 = \frac{21-15}{15} \times 100 = 40\%$$

* * * *

Question: — What is the correct method of regulating air supply to furnace and why?

Answer:—By a damper in the breeching or smoke-box because when the air supply is regulated by the ash-pit door, it is liable to cause the air to come through the openings or cracks in the brick-work, and the cooling effect of the air passing up through the grates prevents their being warped or burned.

* * * *

Question: — Assume a hand-fired furnace with a CO_2 recorder connected indicating a drop from 15% is shown. Give probable reasons for this record step by step.

Answer:—Too thin a fire or "holes," spots burned out; the further drop in CO_2 to 4% is caused by opening furnace doors or the time taken to spread the fire evenly to cover the holes, etc.; and after the green coal or fuel has been added, and as the temperature rises the oxygen unites more perfectly with the carbon and the CO_2% rises to 15%.

* * * *

Question:—Describe what is known as the balanced draft system. Give reasons for and against this system.

Answer:—Balanced draft is a condition where the pressure under the grate-box is equal to the draft over the fire. The condition is obtained by use of force draft under the fire.

* * * *

Question:—Describe the operation of an automatic damper. Give reasons for and against from strictly combustion point of view.

Answer:—An automatic damper operates through the action of a lever lifted or controlled by a diaphragm-valve combination where the motion of the diaphragm subject to variations of steam-pressure is transmitted to the lever which is connected in such a way as to open the damper as the pressure goes down and to close the damper as the pressure increases; however as a rule through lost motion and other frictional losses they are slow in opening the damper and also in closing the damper resulting in higher pressures than are needed and the safety valve blows, thereby causing a serious loss of steam or its equivalent in heat units. Further when the opening is delayed and the boiler pressure is still falling the CO_2 from a combustion point of view is also low. Some manufacturers claim to have made a damper regulator which is free from loss of motion and which will regulate to a pound per sq. in. of the variation of the steam pressure carried.

* * * *

Question:—Give description of a system of combustion control by steam flow, and give reasons why, in your opinion, this method is theoretically correct.

Answer:—In this system of combustion control, the difference in pressure on either side of a venturi-tube is taken advantage of. The tube is introduced in the path of the main steam flow and the slightest change in flow is registered and acts upon an intervening balance-control which in turn acts upon the damper and air admission; also in the case of a mechanical stoker it regulates the rate of coal feed and depth.

WATER GAUGE GLASSES

Gauge glasses frequently break and must be replaced. This is an operation that requires much care and, in this regard, we believe that no better information can be found than that given in an article entitled "Water Gauge Glasses," by Charles S. Blake, now president of this company, which was published in the January 1912 issue of the "Locomotive." Because of the valuable information contained in that article, we are reprinting it herewith.

"The breaking of water gauge glasses is of such frequent occurrence, that a few words concerning their attachment and use may, if heeded, prevent some accident and possibly personal injuries, besides the annoyance of frequent replacements.

"The use of a visible gauge as an auxiliary to indicate height of water in a steam generator has become a recognized necessity, and is required by authorities exercising jurisdiction over boilers. One municipality at least places such

value on their use as to recognize a second gauge glass as a substitute for the gauge cocks and does not require the latter when two gauge glasses are properly affixed.

"The ordinary or customary gauge glass is a plain cylindrical tube, ranging for ordinary use from ⅝ inches to⅞ inches in diameter and of a length to suit the varying conditions and types of boilers. These diameters are outside dimensions. They vary slightly, but as the glasses are set in compressible washers such variation is not detrimental. They are made in this country and abroad but those of Scotch glass are considered the best. The very nature of the material makes it brittle, and aside from its brittleness it possesses other peculiar qualities that when known should cause engineers and firemen to handle these glasses with more than ordinary care. A novice in examining a gauge glass will almost immediately pronounce it defective, because of the fine lines running lengthwise in it; but such lines are usually indicative of good quality and are more pronounced in the Scotch glass than in the American.

"All glasses are keenly susceptible to surface abrasions, even so minute as to be unobservable. If one receives the slightest scratch inside or out, it should not be used, and in handling or keeping them in stock, no metal of any nature should be allowed to come in contact with them. They are particularly liable to break if iron or steel touches them, and so should never be laid down even temporarily with tools, as is frequently done in preparation for a renewal.

"It may sometimes be thought desirable to clean an old glass when it has every appearance of being whole and sound. In such an event, waste or a cleaning cloth should be used and should be pushed through the bore by means of a wooden stick small enough to pass without force. As a rule, however, the price of gauge glasses is too low to bother with the cleaning of old ones, and if one shows any deterioration at its ends, is should be discarded in any case.

"In the prevention of accidents, not the least measure of importance is to have the receptacles for the glass properly attached before trying to insert it. Every one who has had occasion to put in gauge glasses is familiar with the so-called gauge "cocks," which form its support. They are not cocks, however, but valves. In some of the special types of water glass connections, cocks are used as a means of closing, but the percentage in use is very small. The valves are fitted in various ways,—sometimes directly into the boilerplate, more commonly into water columns of cast iron or those improvised from ordinary pipe fittings. The openings to receive the valves should be parallel and threaded an equal depth, so that when the valves themselves are screwed in position the sockets in them for the reception of the glass will be in a direct line. Both top and bottom valves have these sockets bored out to a considerable depth. If the eye cannot detect the valves out of line, the glass should be inserted in them, to more clearly determine whether the valves are in true alignment or not. The glass should be cut to the greatest length that will permit its insertion, one cock or valve usually admitting it to a greater depth than the other.

"In the selection of a glass, one should be used that will freely enter the valve receptacle and leave a little space around it when in position, and the nuts or glands for compressing the gaskets should be large enough not to touch the glass when screwed up. Only fresh, pure rubber gaskets or washers cut by machine, uniform in size, and prepared for such purpose should be used. After inserting the glass in the valves, it should be shifted so that washers will be at an equal distance from its ends. This is very important, for the writer in his investigations of boiler explosions has found two instances where a washer softened by the heat, under pressure of the gland, has squeezed out under the glass and closed the opening, thus permitting a false indication of the water level.

The glands should first be screwed by hand, each a little in turn until they can no longer be moved by the fingers. Then a small wrench may be used on them alternately, until the glass is firm in the packing. Care should be taken that the glass does not shift in its vertical position, during this operation.

"It may be needless to say that in renewing a glass with pressure on the boiler, the valves should be closed tight and the drip opened to release the pressure before attempting the removal. When a new glass has been put in, if the valves are not provided with means for opening at a distance, a board or sheet-iron shield large enough to protect one's head should be held between the face and the glass, and the valves then opened very easily and slowly to their full extent. When they are open, it is advisable to retire with the shield in front of the face to observe at a distance whether there are any leaks, and if any appear, to return to the glass with the face still protected, shut off the valves, release the pressure through the drip, and then tighten the nuts. Never under any circumstances attempt to tighten them with pressure on the glass.

"In the writer's experience, he has found it possible to make the joints tight by only a slight pressure of the wrench and whenever he has found gauge valves out of alignment he has trued them up. As a result of this practice during considerable experience with marine and stationary boilers never has he had a glass break under pressure.

"If gauge glasses are properly handled and used they will withstand great extremes of temperature, although it is well to guard against drafts from outside in cold weather. In the selection of glasses it is not necessary to pick out the ones with the heaviest walls, for these with slightly lighter walls are as strong and will last as long as the thicker ones.

"The great precaution is to keep the surface from being scratched, for, as every engineer knows, it requires but the slightest breaking of the skin of the glass in a circumferential way to cause it to almost fall apart. The peculiar phenomenon of the glass breaking which has lain next to iron or steel has never been explained to me, but I have a number of times as an experiment, taken a glass, run a smooth rod of iron through it and put it away. Sooner or later it has been found shattered in many pieces. My first observation of this phenomenon was when I placed a glass on a shelf in an engine room with a large pocket knife against it to keep it from rolling off. The next day I found the glass all in pieces, but the pieces in the respective positions, showing that the breakage was not from violence, else the piece would have been scattered."

ENGINEERING NEWS

The New Orleans Association of Commerce has requested the assistance of the Bureau of Mines in an educational campaign looking toward the abatement of the smoke nuisance in that city without necessitating the passage of legislation to accomplish the desired end. The Chamber of Commerce of Akron, Ohio, has also been in correspondence with the bureau regarding an anti-smoke campaign in that city.

The objects of a new investigation being undertaken by the Bureau of Mines at the Pittsburgh experiment station on the determination of composition of gases arising from a thin fuel bed are: by blowing air at known rates through a fuel bed of known thickness, formed from anthracite, coke or bituminous coal, to find out the quantity and composition of the gases above the fuel bed; and so show how much air must be admitted to burn their combustible constituents.

Tests have been made at the Pittsburgh Experiment Station of the Bureau of Mines on the Speller process for removing dissolved oxygen in hot-water heating systems. This process endeavors, by removing dissolved oxygen from the water, to retard corrosion of the hot-water pipes. An instalation has been in use at the Pittsburgh station for about a year. The first test showed that the water heater did not heat the water to a high enough temperature when the most water is being used in the building, so the heater was covered with asbestos and a second test made. The oxygen deactivator proved efficient in removing dissolved oxygen provided the water entering the deactivator was kept at about 170°F. The investigation is being continued.

Cooling Water for Air Compressors

N operating Air Compressors every engineer knows that it is necessary to circulate cold water through the water jacket of the air cylinder to keep it from becoming over-heated, but few have considered what is the most efficient temperature to strive for, that is whether it would be better to have more or less water passing through. Like everything else there is a point where the most efficiency will be gained and while it may not be possible to attain this condition, the knowledge of what is the most economical amount of cooling of the air cylinder enables us to intelligently control the cooling water to gain the highest possible efficiency under a given set of conditions.

At first glance it would seem that whatever heat was carried away by the cooling water was wasted, because this heat having been converted from the energy put into the air compressor all the heat that went into the cooling water represented so much wasted energy, and therefore the less cooling water we could get along with, and still not get the cylinder dangerously hot, the less energy would be wasted. That all the heat transmitted to the cooling water is derived from the energy supplied to the air compressor, and that such disposal of it is wasting the energy is quite true, but as will be explained later on in this article, all the energy in the air that is represented by its increased temperature is inevitably wasted, and it is more economical to remove it from the air as quickly as possible, than to leave it in the air to be slowly dissipated later on.

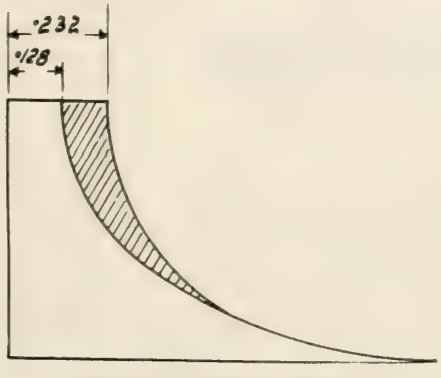
To understand why this loss of the energy contained in the air in the form of heat is inevitable, it is necessary to know what happens while the air is being compressed, and when it is put to work in the air tool. Starting with air at atmospheric pressure and temperature, the whole of the energy used in compressing the air is converted into heat, the foot pounds of energy exerted by the compressor drive being exactly equaled by its equivalent in British Thermal Units added to the air as indicated by the rise of temperature of the air, neglecting friction. In actual practice owing to the necessity for storing the compressed air to meet the fluctuating demand, and because of the length and multiplicity of piping required to carry the air to all the various tools, it is manifestly impossible to retain the high temperature in air, and it practically always fall back to atmospheric temperature before being put to work.

The statement that all the energy used in compressing the air is converted into heat, which is dissipated and lost, seems to be an anomalous one, as if all the energy put into the air is thus wasted, how comes it that the air can still perform useful work after losing all the heat or energy expended upon it? This is explained by the fact that there is energy in the air, by virtue of its containing heat at atmospheric temperature, and the act of compressing it makes this heat available as a source of energy. That is, the air in expanding performs work, and falls still lower in temperature, the heat units given out being equivalent to the foot-pounds of work done.

Obviously the if the air is in any case going to lose the heat gained in compression, there is nothing to be gained by curtailing the amount of cooling water passing through the air cylinder, it beginning in practice to dissipate the heat as fast is it is generated. Coming now to the saving to be gainned by removing this heat as rapidly as possible, if we take a cubic foot of air at atmospheric pressure and sixty degrees temperature Fahrenheit and compress it without cooling to one hundred pounds gauge pressure, it will give us .232 cubic feet of compressed air at 485 degrees temperature. After leaving the compressor it will cool down to atmospheric temperature again, say sixty degrees, and will if kept at the same pressure, contract in cooling to .128 cubic feet. If on the contrary it was possible to dissipate the heat as rapidly as it was generated, and so keep the air at its initial temperature during compression, the cubic foot of free air would be compressed to .128 cubic feet in the cylinder, and there would be no subsequent contraction.

The output from the compressor, that is in cubic feet of compressed air in the receiver at atmospheric temperature will be the same in both cases, other conditions being the same, but when the air is uncooled it will reach the full pressure in the air cylinder when the piston is still .232 of its stroke from the end of the stroke, while when the air is kept cooled to the initial temperature, the full pressure will not be reached until the piston is at .128 of its stroke from the end. The result of this is shown by the diagram herewith, which shows a theoretical indicator diagram for an uncooled compressor, imposed over one for a theoretically perfectly cooled compressor.

The larger diagram represents the first case, and the smaller diagram the latter, and the shaded area represents the additional energy which has to be exerted to compress the uncooled air, over that necessary when the heat is dissipated as rapidly as it is generated, the useful energy made available being the same in both cases. The extra power required is about fifty per cent. of the total needed for theoretically perfect cooling.



Theoretical Indicator Diagram

Of course a compressor is never run without some cooling, as the temperature reached would be destructive, nor is it practicable to remove all the heat from the air due to compression, while the air is being compressed, but this latter condition is the one to aim for, as the economy is increased considerably the nearer we approach to keeping the air at its initial temperature.

While it is usually impossible to keep the compressed air at a temperature any higher than that of the shop in which it is being used the higher the temperature at which the air is used the better, as there will be less heat wasted, and therefore the air tools should be as close to the compressor as possible, and the air piping as short and free from unnecessary ramifications as possible. Obviously the air should never be cooled below the temperature at which it will enter the tools it is to drive, but all the cooling that is possible down to this temperature should be done while the air is being compressed.

If the incoming air to the compressor can be had at a lower temperature than that at which the air enters the tools, the difference in temperature gives a clear gain of available power, as the lower the initial temperature the lower will be the final temperature in the compressor, and hence there will be less heat to be wasted in cooling the air to the temperature of the shop. For this reason the air inlet should always be piped to the coolest point available.

For those exceptional cases where the air is used at a point quite close to the compressor, and the air does not have time to lose its heat in a receiver, or in traveling through long pipes, it is wasting energy to cool the air below the temperature that the tools to be driven will work successfully with. This high limit of temperature may be taken as 300 degrees Fahrenheit.

The water service pipes for air compressors are not usually as carefully laid out as they ought to be. A common fault is to run a main water service pipe past a number of air compressors and connect each cylinder by a branch pipe from this main. This results in the water taking the easiest course, or in other words, short circuiting through the cylinder that offers the shortest or easiest way to the ultimate outlet, leaving the other cylinders with too little water passing through them to be effective. When more than one cylinder is connected to the same main, there should always be a valve at each cylinder to enable the operator to control the division of the available circulating water and divert the main quantity to the cylinders requiring it.

A COMMUTATOR REMEDY

By J. Mendellsohn

Some time ago I took charge of an isolated plant, which had amongst other equipment, two 10 K. W. direct connected D. C. units. These were giving a lot of trouble with sparking and blackening the commutator.

Although I sandpapered the commutator and spaced the brushes, the sparking was getting worse and I had almost reached the point of giving up the job when I remembered having read that boiling the brushes in vaseline might help. I tried that and found to my satisfaction that there was some improvement, but unfortunately it did not last long, and in a week the trouble was just as bad as before.

I again boiled the brushes, but instead of spacing them this time, I set them with the aid of a milli-voltemeter at a point where there was the least difference of potential between the edges of the brushes, and after turning the commutators, the machines ran satisfactorily for six months, after which they only needed sandpapering again.

DESIGN OF DYNAMO

Question:—I want to build a dynamo to carry about twenty lights of 32 candle power. I have built smaller machines of about 1/20th horsepower, but do not know how to go about a larger one. Can you tell me how much wire and what size I would require for the armature, and also the size of the field coils? —J. S.

Answer:—This enquiry involves the complete design of a dynamo, which is a rather complicated matter to explain in this short space. The amount of wire required for the winding of a dynamo of the capacity you mention to work at 100 volts, as this depends on the speed, size of armature, nature of winding, whether lap or wave, series compound or shunt wind, number of poles, class of iron used in armature and poles. If your lamps were standard 40 watt lamps twenty of them would take 800 watts, and this at 100 volts would be 8 amperes. The capacity of the armature for current depends on the cross section of its conductors. This should be such as would allow about 2,000 amperes per square inch of conductor. A number 12 wire would do for this purpose as it has a carrying capacity of 10.2 amperes. The e.m.f varies directly as the square of the core and the number of turns on the armature.

To generate one volt it is necessary to cut 100,000,000 lines of force per second. Roughly allowing only 80 per cent of the number of turns to be effective, and assuming the class of iron used to have an intensity of 20,000 lines per square inch, would suggest making the armature seven inches diameter by 14 inches long. The wires laid in this would be in the form of a rectangle of 14 by 7 inches or 98 square inches, and this multiplied by 20,000 lines of force gives 1,960,000.

If we assume the speed to be 15 revs. per second, 900 per minute, this would give us 32,800,000 lines cut by one coil, but the coil having two sides would cut them twice every revolution. It would therefore only have to cut half the number of lines for 1 volt, therefore, 100,000,000 divided by 32,800,000 equals 3 turns for one volt or 300 turns for 100 volts plus 20 per cent. Assume you use four pole pieces and they are shunt wound, allowing 3 per cent for excitation current, you would need roughly about 1000 feet divided evenly over the four poles, number 24 wire.

All this is of course only approximate, but it shoud suffice, as we are not making a scientific design.—G. R. A.

BUILDS HIGHEST VOLTAGE SINGLE TRANSFORMER

Another achievement has been added to the long list of engineering feats of the engineers of the Westinghouse Electric & Manufacturing Company in the construction of the highest voltage single transformer ever built.

The transformer, which is 1,000 kv-a., capable of delivering 1,000,000 volts above ground was built for the Westinghouse Electric & Manufacturing Company's experimental laboratory at Trafford City, Pa. It is believed to be the only single transformer of such high above ground voltage ever successfully built and now in operation, having been installed recently at the Westinghouse laboratory.

The product has some novel winding features which make it exceptionally well suited for very high voltage work. It is of the core form construction which has always been used in the design of high voltage testing transformers.

The windings of this new transformer contain nearly 70 miles of wire and are assembled on the principle of a condenser bushing. It is divided into many cylindrical coils, each coil consisting of one layer of copper or turns wound on a micarta tube. As the coils increase in diameter, they shorten in length, precisely as does a condenser bushing, except that the tapering of the winding is the same at both ends. The turns of copper in the transformer take the place of the tinfoil in the condenser bushing.

The two sets of windings, one on each leg of the core, are cross-connected so as to produce a progressively increasing voltage above ground from the inner, or smallest, diameter coils to the larger diameter coils.

The windings of the large diameter or line coils consist of treated cloth covered cable so as to withstand surges that are produced when the apparatus being tested flashes over. A condenser bushing is used for bringing the line lead out through the cover of the tank.

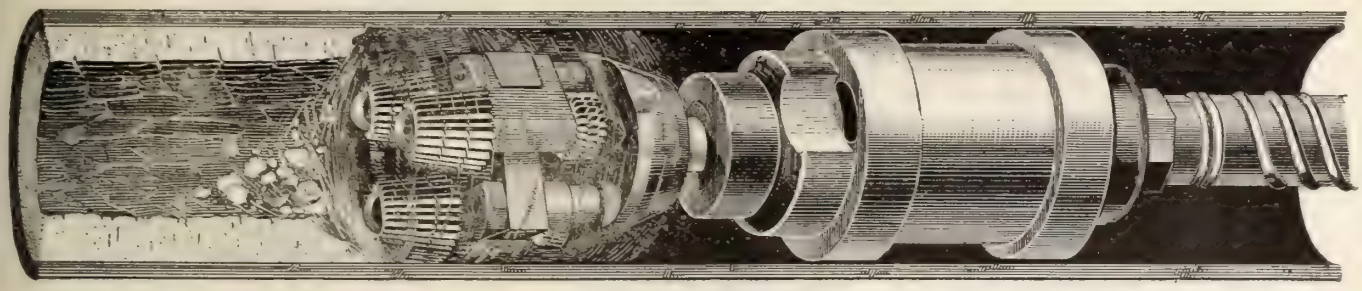
The transformer is built on the principle of distributing electrostatic stress as developed by C. L. Fortescue, of the Westinghouse Electric Company, about eight years ago.

The terminal bushing is the largest ever built in the Westinghouse shops and on this account, special machines had to be fitted to turn the bushing. Its length is 19 feet and it is 41½ inches in diameter and weighs about 9,000 lbs. The static shield is 10 feet in diameter and 20 inches deep.

The construction of this high voltage testing transformer is the result of research work by Westinghouse engineers. The Westinghouse Company has made research a feature of its activities, believing that such work must necessarily precede commercial progress in any line. This has been particularly true in the matter of the gradual increase of transmission voltage. Testing facilities capable of producing voltages four or five times as great as the transmission voltages are necessary in connection with the development work on insulators and apparatus.

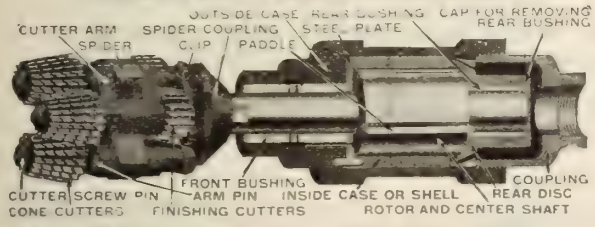
Some testing in the past has been done at voltages approximately 1,000,000 volts, but these tests were accomplished by connecting two transformers in series, grounding the connection between them and using the voltage between line terminals. One million volts was produced first in this way by the Westinghouse Electric & Manufacturing Company in 1913. When conducting tests by this method, an artifical ground is used

(Continued on page 46)



Scale is Too Expensive a Luxury for *Your* Plant

LAGONDA TUBE CLEANERS

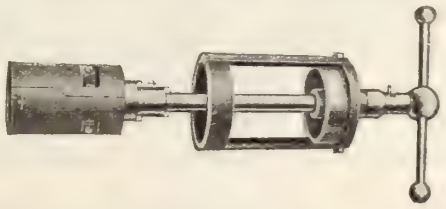


Sectional View, Lagonda Air or Steam Driven Cleaner

Lagonda Boiler Tube Cleaners are built right in every detail. They are fast, but thorough, long-lived, simple in construction. The above illustration shows a sectional view of the air or steam driven Cleaner.

Lagonda Cleaners are made to be driven by air, steam or water, and in all sizes for straight tubes or curved, in fire tube or water tube boilers. We will gladly send catalog and give full particulars.

LAGONDA TUBE CUTTERS



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Cutting boiler tubes is a simple operation when you are equipped with a Lagonda Tube Cutter. It makes a quick, clean cut, may be operated by one man and can be equipped with extension shaft for cutting tubes at any point. Descriptive bulletin and full information upon request.

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STOKERS AND FURNACES
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ETC., ETC.

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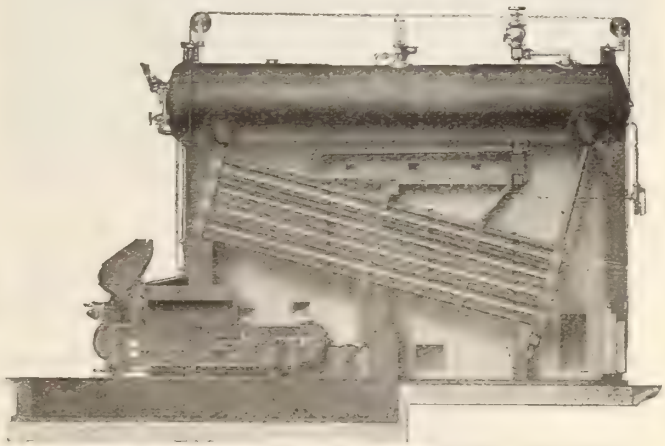

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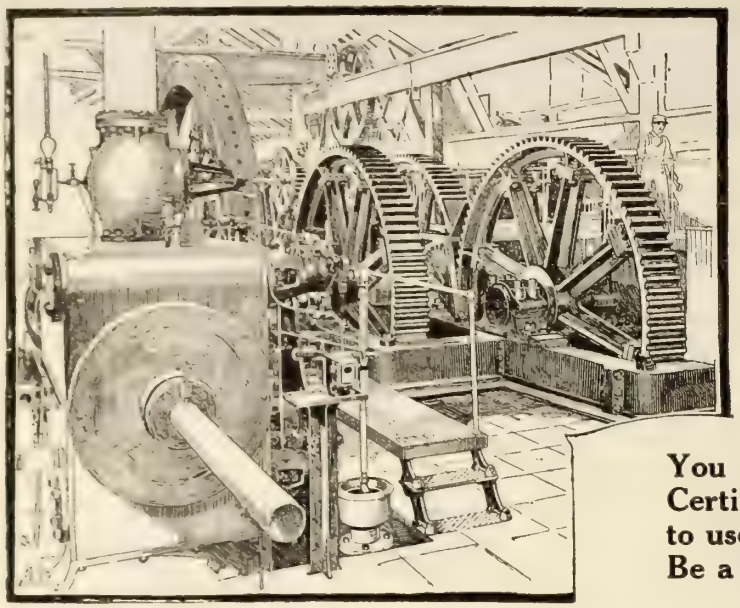

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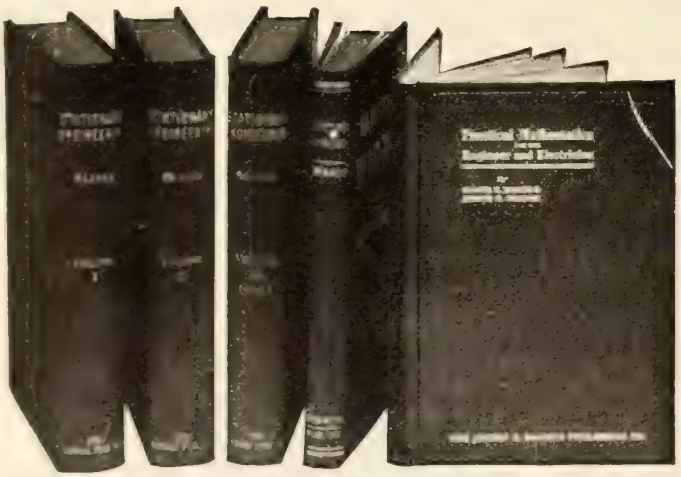

covering every branch of power plant work, including Steam Engineering, Practical Mathematics, Electric Wiring and Mechanical Refrigeration. The Course has been prepared by a staff of experts working under the personal supervision of Joseph G. Branch, B. S. M. E., for many years Chief Engineer of the City of St. Louis and head of the Examining Board of Engineers for that City. Although complete in every detail, the Course is written so simply and clearly that **anyone can understand it.** No useless theory—but all the straight facts you need to pass the Engineer's Examinations and become a Chief Engineer.

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Present Position .....

The new building planned by Ontario Hydro Electric Commission on University Avenue, Toronto, will cost approximately $500,000 and will involve about 450 tons of steel. It is understood that the Robert Redford Co. is considering the erection of an office building near Bay and Wellington Sts. This building erection is under contemplation but a definite decision is not expected for several weeks at least. The highways department of the Ontario Department of Public Works is proceeding with some bridge construction. A larger programme of bridge construction is understood to be under consideration.

The Midland Engine Works, manufacturers of steering engines and gasoline marine motors, are adding to their line a marine motor of the Scripps type. For the present, they will build them in four cylinder size, 25 to 40 horse power adaptable to cruiser types of boat from 35 to 40 feet or for speed boats 20 to 25 feet length. J. Bruce Hanly, the manager, who is an authority on motor and water boat construction, states that for a wide range of purposes this type of engine appears to him as one of the most uniform in his experience. In time he hopes to develop three sizes, two, four and six cylinder. His plans are to have 25 ready for the early summer demand.

Canada Electric Castings, Limited, are building on the site of the foundry of Canada Electro Foundries, destroyed by fire, a two story foundry 250 ft. by 50 ft., for which they are using the steel frame and other material bought from the Baldwins when they dismantled the Collingwood Steel foundry. W. H. R. Burrows, the manager, states that he hopes to have his new plant in operation by the middle of April. He is specializing in steel castings, including grinding balls, for the mining and concrete industries. His equipment will include 2 electric, three phase furnaces of the Heroult type, with Volta attachments, giving him a daily capacity of 18 tons.

Rebuilding of furnaces and extensive additions to the plant of Pilkington Bros. at Thorold, Ont., are responsible for a temporary close down of the plant, according to a statement issued by J. E. Harrison the Canadian general manager of the company. Coupled with that statement, Mr. Harrison declared that he was looking forward to a revival of the building trade that would control to an extent the speed with which the alterations would be accomplished.

Electrical energy is the power of the present and is likely to become more important year by year in the life of the Canadian people. A writer in Pulp and Paper magazine stated lately that the investment in electrical development of Canadian water powers is already $475,000,000 and will be not less than a billion dollars by the year 1940, if the present rate of growth in installation continues. The power now utilized represents coal that would cost $148,000,000 yearly. By 1940 it would be necessary to burn 42,000,000 tons of coal yearly at a cost of $336,000,000 to provide the power this writer estimates will be produced from Canadian waterfalls.

The British-American Fuel & Metals Ltd., McKinnon Bldg., Toronto, are representing in Canada, sixteen mines of the Pittsburg and Younghiogheny districts, also the West Penn. By-Products Co. The object of this company is to give a direct service between the mines and the consumer. In their fuel departments they have a production of bituminous coals of nearly 10,000 tons per day. The directors include some well known steel manufacturers and coal producers on this continent. The general manager, Major S. Snell, A.M.E.I.C., late Royal Engineers, states that the company has successfully sold fuel to consumers in Canada upon a technical basis, and that they are in a unique position to supply consumers with a fuel most suitable for their requirements and thus secure for them, the greatest economy and efficiency.

Yarrows Limited, Vancouver, B. C., has been awarded the contract for repairs to the Government steamer Givenchy which struck and was submerged for six weeks near Bella Bella, three months ago. The work will cost about $10,000.

Commenting on the possibility of a strike among the coal miners of the United States, H. A. Harrington of the Coal Exchange of Canada stated that a lengthy duration of suspended operations, would result in considerable inconvenience to users of American coal in Ontario. Canadian authorities will likely take steps to minimize coal shortage.

McColl Bros., 67 Bocelier St., Ottawa, will erect a warehouse and three storage tanks.

SOME BOILER QUESTIONS.

(Continued from page 37)

Question: — Would you recommend steam soot blowers, where steam is at 100 pounds pressure, or, would it not be better to use compressed air with these soot blowers?

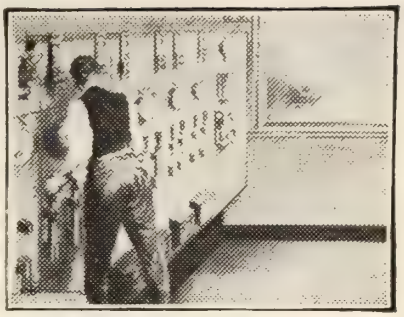
What do you consider the correct distance for grate of boiler for a return tubular boiler, 75 H. P.?

With a grate surface of 25 sq. ft., what evaporation should we expect? How much soft coal should this burn?

If we should lessen our grate surface, would it be practical to shorten the grate surface alone, rather than both narrowing and shortening grate surface?

Do you recommend graphite to be used in the boilers? If not, what do you recommend?

Answer:—It is preferable to use steam for soot blower purposes owing to its higher temperature and also because it is likely to be much more free from moisture than air. Further, you have a means of blowing whenever there is steam on the boiler without



Careers for Canadians in ELECTRICITY

As Canada, with its unrivalled water-courses, is now a wonderland of electric power, Canadian youths have a field of unlimited opportunity in which to win real success in life. In the near future there will be amazing electrical development throughout the Dominion and every boy and man who knows the why and the how of electricity—who has been trained to apply his knowledge with skill and understanding—can at all times be assured of a well-paid position and have within his reach one of the rich plums of the industrial world.

Boys! If you are ambitious, or if you would ensure against indifferent wages and perhaps frequent unemployment, you could hardly do better than take the necessary steps to become expert in some special branch of electrical work. Let us send you a Booklet of information about the famous method of the International Correspondence Schools, which is fully qualified to help the boy or man who really wishes to enjoy the advantages of a substantial career, in electricity or any other important line of work.

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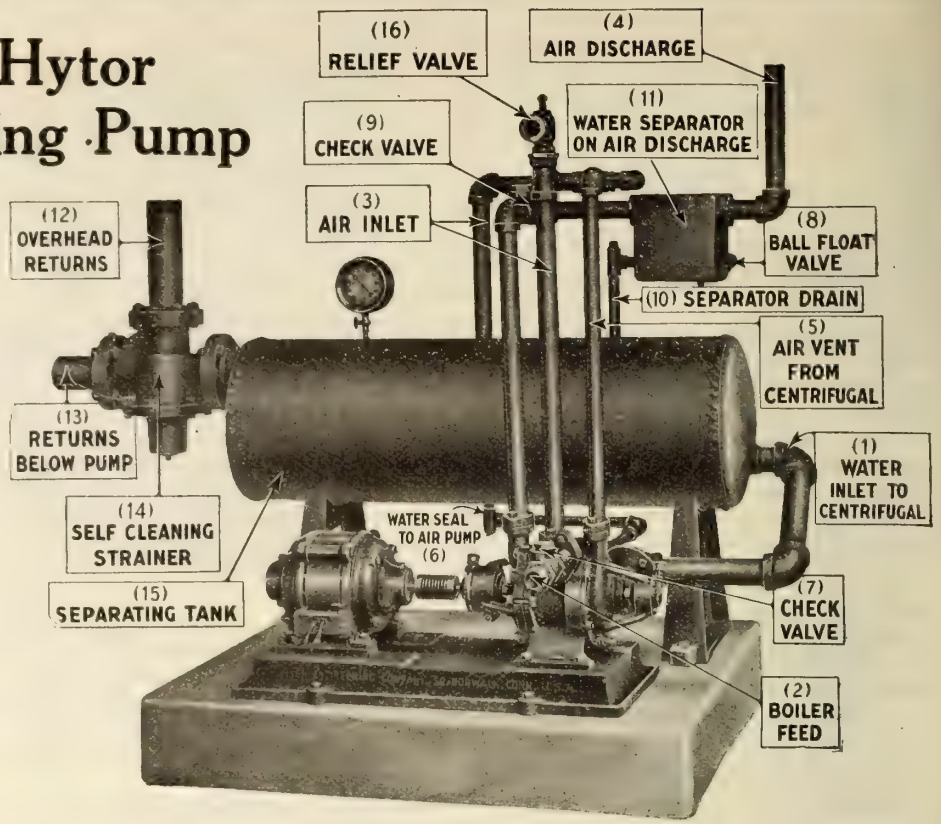
The Jennings Hytor Vacuum Heating Pump

THE ADVANTAGES of vacuum in connection with steam heating are well understood, but in installing equipment consideration should be given economy, efficiency and durability. In these respects the **Jennings Hytor Vacuum Heating Pump** deserves careful attention. It is distinctly in advance in principles of design compared with other types; principles of design which assure reliability, perfect service and low upkeep cost. Another feature is compactness, and the horsepower required for its operation is less than half that consumed by other vacuum heating pumps of similar capacity. **Study the illustration, then write for catalog.**



The Arthur S. Leitch Co., Ltd.

1001-2 Kent Building
TORONTO

having to start up an air compressor for this purpose.

A return tubular boiler of 75 horsepower should be set with the shell of boiler at least 38 inches above the grates and 42 inches would be a good height.

With a grate surface of 25 square feet and natural draught you should be able to burn 300 lbs coal per hour.

Your evaporation will depend on the temperature of feed water and the pressure of steam carried. Eight pounds of water per lb. of coal is an average performance.

It is quite practicable to shorten the grate only and this makes firing easier as well as cleaning. There is not much difficulty in getting at the side of the grate but there is at getting at the back of a long grate.

Graphite is useful under some circumstances and can be used with safety. Without knowing the conditions of the particular boiler referred to I would not make any recommendations

SULPHUR IN COKE

The general problem of decreasing the sulphur in metallurgical coke and devising desulphurization processes demands that some knowledge be had of just how the sulphur in coke occurs. Unfortunately this is not known and has led to several futile attempts to determine in what form the sulphur in coke occurs. A new method of attack has been outlined by the Bureau of Mines which promises to give much more information on this subject. This method makes use of the passage of hydrogen through the hot coke thereby giving a means for measuring the dissociation pressure of the carbon-sulphur combination. Application of the phase rule to these results will indicate whether the sulphur is present as a compound, a solid solution, or absorbed. The results so far obtained by the Bureau of Mines seem to indicate the presence of a compound but further work will be required to substantiate this and study its properties.

HEAT OF DISTILLATION.

An investigation regarding the heat of distillation of coal is being conducted at the Pittsburgh, Pa., experiment station of the Bureau of Mines. This investigation has for its object the determination of the amount of heat evolved or absorbed through chemical reaction during the process of destructive distillation of coal. Such information will be of value to the by-product coking and gas industries in that it will give them a more accurate knowledge of the thermal requirements of their ovens and retorts. The problem is being attacked by distilling small amounts of coal in a bomb calorimeter, the necessary energy being supplied electrically and being accurately measured by electrical means. The heat effect of the standardized amount of electrical energy required to distill the coal is measured in the calorimeter and compared with the effect of the same amount of energy supplied to the products of distillation in the calorimeter during a parallel experiment. The difference between the two effects gives the reaction heat of the coal, positive or negative as the case may be.

BUILDS HIGHEST VOLTAGE

(Continued from page 42)

which is one-half of the test voltage below ground. Results obtained by this method, however, are rather questionable, even when conducted with great care. Much more reliable tests can be made by means of a single transformer capable of delivering the full test value above ground. The necessity for such accurate test data resulted in the construction of the new testing transformer by the Westinghouse Company.

The Bureau of Mines has undertaken, at the Pittsburgh Experiment Station, an investigation of the mechanism of scale formation in steam boilers. The object of the investigation is to determine if the character of the precipitates forming in boilers may be made to assume a form in which they do not attach themselves to the walls, and also to ascertain if the material in the boiler wall exercises any influence. The work will be done in co-operation with a company manufacturing combustion appliances, which will bear all expenses.

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And there are no better tools than WILLIAMS' Superior Drop-Forged Hammers. All kinds; all sizes. Catalog on request.

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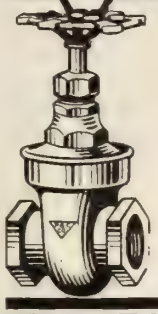
P&C CO



Pratt & Cady Bronze and Iron Valves are made for all purposes and pressures. They give long and satisfactory service.

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Reading Open Hearth Fittings come in all shapes and sizes—flanged and screwed—for oil, water, gas and steam lines.

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Saves When You Use

Time is a big item of cost in testing gauges. With an Amercian Dead-Weight Gauge Tester you can test three or four gauges in the time ordinarily required to test one with most other instruments. This is partly because you can hold the pressure at any point as long as desired, thus making it quick and easy to take accurate comparisons of the gauge reading at any point on the dial with an

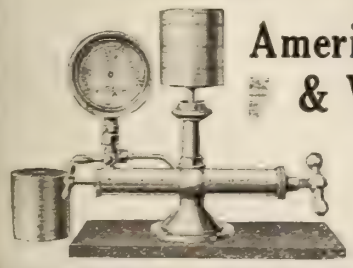
AMERICAN DEAD WEIGHT GAUGE TESTER

Another time-saving feature is in the fact that the American is the only completely self-contained tester on the market.

In addition to saving minutes and therefore saving money every time it is used, the American also saves money in the long run, for its rugged construction means long life. It is lighter, less bulky and therefore handier to carry around than most testers.

Made in various sizes for pressures from 5 lbs. up to 1000 lbs. Other equally effcient types for higher pressures.

Our interesting Gauge Tester Circular sent on request.



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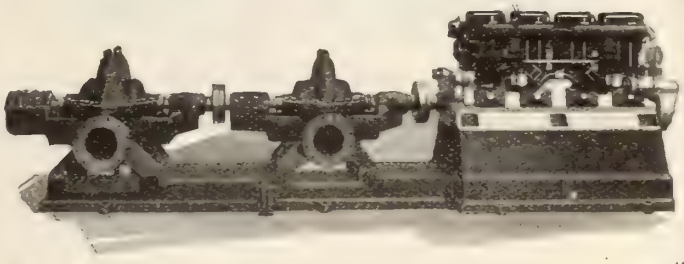
What Does Your Town do for Water When Power is off?



Model GRC-8 cylinder Sterling high duty gasoline engine direct connected to two 10″ single stage Delaval centrifugal pumps installed at Edmunston, N.B., by E. Laurie & Co., Montreal. Capacity 2,100 G. P. M. against 270 ft. head at 1,200 R.P.M.

Engine costs $20 per H.P. Compare it with any other prime mover.

Catalogue on request

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12 to 300 H. P., 900 to 1,500 R. P. M.

Get Behind the Premier!

THE amazing facts of Canada's immense loss of population within the past few decades—as revealed by the census—have given a rude shock to all thinking Canadians. To retain its newcomers as citizens and the sons of its citizens as builders of the Dominion, Canada must assure them at least a modicum of prosperity. In a forceful, trenchant, characteristic article, Agnes C. Laut discusses these issues in the

MacLean's Magazine for March 1st

"What we need," says Miss Laut, "is an united Canada—one unified puissant nation. Each little unit—the Maritime Provinces, Quebec, Ontario (the manufacturers' Paradise), the Prairie Provinces, British Columbia—has pulled for its own little ends, its own little local wants, forgetting that a nation—like a human body—can only attain perfect well-being when all the parts are in well-being, from its little toe (with apologies to P.E.I.) to its stomach (with my compliments to the grain-growing prairies). . . . .

"Mackenzie King won. My hat off to him and my sympathy with him; if I had twenty-five thousand miles of adhesive plaster in my possession I would send it to him, to help bind up in unity of aim, action and destiny the disruptive forces of class, creed, race, section, which he must unify if Canada is to avert financial catastrophe and forge ahead in his lifetime to a nation of forty to fifty million people, as it ought."

A Peaceful Session? Perhaps!

By J. K. Munro

The tariff is dead and will stay dead—until the next election; the railway issue is dormant but will show unmistakable signs of life. So says "J. K.," in a timely political article in which he discusses whether the members of the new Cabinet will make the House a talker's Paradise or a worker's sanctum.

Other Striking Fact and Fiction Features:

RANCHING ON THE BOTTOM OF A LAKE—by Charles C. Jenkins. The romantic story of the Kleskun Ranch, which a few years ago was several feet under water, and now—!

TAKING DOWN OUR MEMBERS—by T. M. Fraser. Some of the humorous side lights as viewed by the Hansard reporters in the House of Commons, during the past half century.

WETHERELL'S ROMANCE—By Sullivan.—A poignant piece of short fiction, by a master writer, describing what happened when a consumptive tried to sell mining claims in London, England.

TOTEM POLES.—By Charles P. Cushing. A story of British Columbia and Alaska, of a man who found romance in business—and how he wavered between two girls.

MOSTLY SALLY.—By P. G. Wodehouse. The conclusion of this entertaining serial, in which Sally meets her just reward. And Ginger gets—well—.

PRICED ABOVE RUBIES.—By Luella Stewart . One of those graphic little bits of a cross-section of real life, delineating a story as old as the hills, but ever absorbing.

THE MAUVE MICRASTER.—By G. Appleby Terrill. The account of what happened when a Professor, who collected queer stones, and a girl, who had a queer brother, fell in love with each other.

THE MARCH HARE.—By Guy Morton. A business romance, on facts which recently occurred in a prominent Canadian industry; this handsome young business man not only makes very satisfactory profits by turning the tables on his rivals, but manages to secure a beautiful girl as a prize.

BACK TO THE DAYS OF COTTAGE CRAFT.—By Gertrude E. S. Pringle. Miss Helen Mowat started her industry with $10 capital—and more than a moderate amount of brains. But—she had an idea—and last year she paid out $12,000 to her workers.

Review of Reviews.—This department alone is worth far more than the price of the magazine. It gives a review of world-wide matters of current interest, condensed in most readable form.

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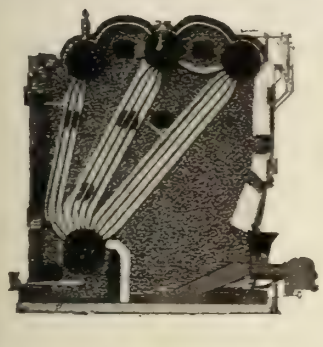

Illustration at left shows the use of Plastic Fire Brick in a modern high stoker - fired furnace, including side and front walls, door arches, bridge wall and baffles.

One-Piece Boiler Furnace Linings

Complete linings including door arches, side walls, and bridge walls are easily built in any type of boiler by any intelligent workman without special forms, shapes or previous experience. A pair of willing hands, a mallet and trowel being the only tools necessary. The use of Betson linings and baffles increases efficiency of boilers, reduces repair costs and saves the fireman a lot of hard work.

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PLASTIC FIRE BRICK

is not a coating or surface finish, but a plastic material from which solid one-piece fire brick wall linings are constructed. It is a compound of fire clays of highest refractory properties and capable of withstanding the stress, strain and wear to which boiler linings are subjected.

Betson's is backed by over twenty years of satisfactory service. Do not experiment with substitutes or imitations.

We have prepared a booklet with much valuable information for the man interested in the care of boilers. A copy is yours for the asking.

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STEAM DRIVEN DUPLEX PUMPS POWER DRIVEN

All parts made to gauge and interchangeable.

Give us opportunity to figure on your pumping requirements.

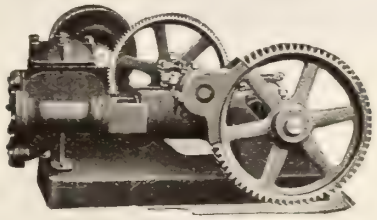

FIG. 7404

POWER PUMPS

Made in piston and outside center packed plunger pumps for both top and side motor mounting.

FIG. 7284

BOILER FEED AND GENERAL SERVICE PUMPS

Direct Acting Steam Pumps for All Conditions of Service and for All Industrial and Public Utility Purposes.

FIG. 7295

PACKED PISTON BOILER FEED PUMP

Established 1852

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Our pivoted-block Thrust Bearings are a complete solution of all thrust-bearing problems in hydro-electric units, steam turbines, ships' propeller shafts, centrifugal pumps, and similar work involving heavy loads and high or low speed.
Maximum Durability and Reliability.
Lowest possible Friction.
No limit to loads or speeds.
Protected by numerous Canadian Patents. Complete manufacturing facilities in Canada, insuring prompt deliveries and service.
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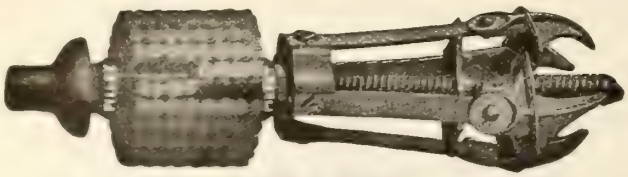
Kingsbury Machine Works
Frankford, Philadelphia, Pa.

The Simplest and best cleaner on the market is



PILLEY'S
Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

"Pop Off" Steam Carries Ashes Away

"Into the hole and away they go" describes ash removal with a Green Steam Jet System. At the Kewanee Boiler Co., they use "Pop off" waste steam to do the work.
Write to Dept. X for descriptive literature.

GREEN ENGINEERING COMPANY
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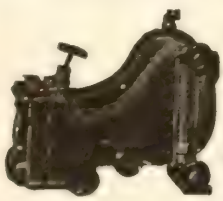
EAST CHICAGO INDIANA

McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE



Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
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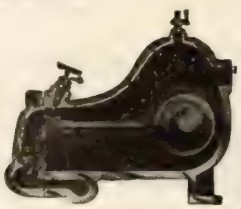
Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.



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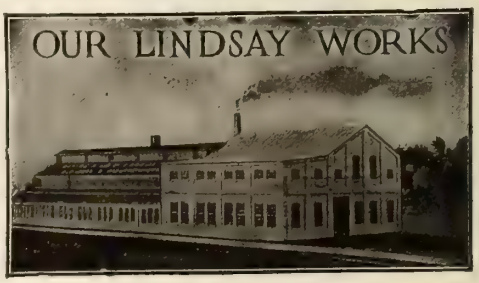
WATSON & McDANIEL CO.
No. 148 N. 7th St., PHILADELPHIA, Pa.

Water Turbines, Hydraulic Governors, Centrifugal Pumps



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Lindsay, Ontario

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For Sale—Steam Plants

1—Complete plant, consisting of two 72" x 18' boilers with tandem compound Corliss Engine, belt, etc., complete.
1—plant consisting of 72" x 18' boiler with 100 H.P. automatic engine complete
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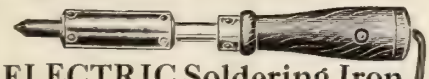
VIMY  **ELECTRIC Soldering Iron**

No waiting for iron to heat. Heats instantly—regulated by handle.

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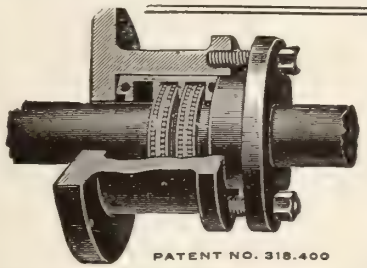

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Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

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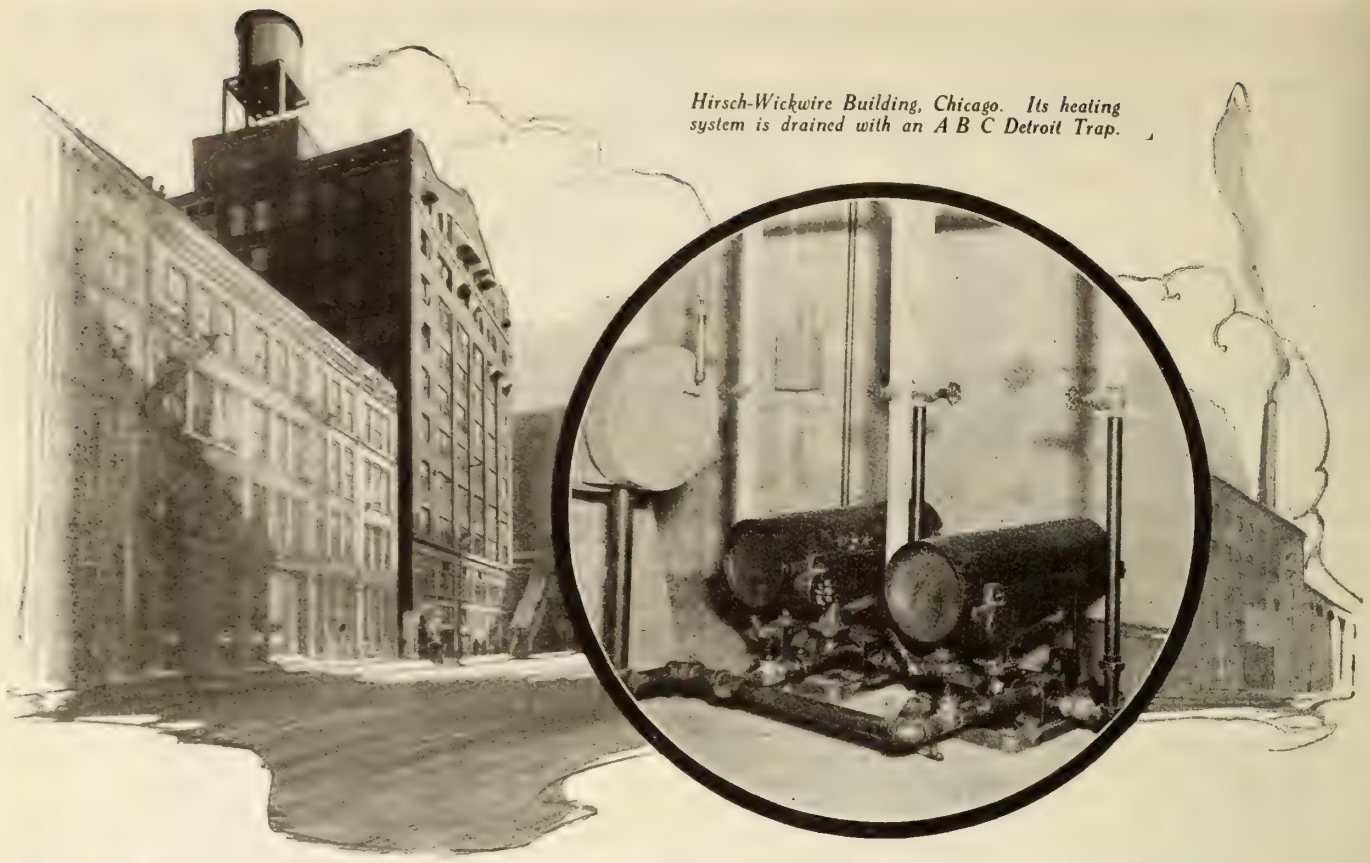

Hirsch-Wickwire Building, Chicago. Its heating system is drained with an A B C Detroit Trap.

Keep Your Steam Heated Equipment at High Temperature—Return Your Condensation Direct to Boilers and Eliminate Pumps—Save 15 per cent. of Coal

Steam drainage equipment if properly installed, will keep your steam-heated machinery and apparatus at high temperature and speed up production.

Efficient steam drainage is made certain with the A B C Detroit Trap System which returns the condensation at high temperature direct to your boilers.

By returning the condensation to boilers, without the aid of pumps, a fuel saving is effected because it is not necessary to allow the condensation to cool to 212 degrees—the highest temperature at which the condensation can be handled by pump.

If you are operating a plant with steam power—if you have a steam drainage problem—bring it to the attention of our engineers. Let us demonstrate that with the A B C Detroit System you will not only increase your production but you will also lower your fuel cost at least 10 per cent. Write for our booklet completely describing the A B C Detroit System.

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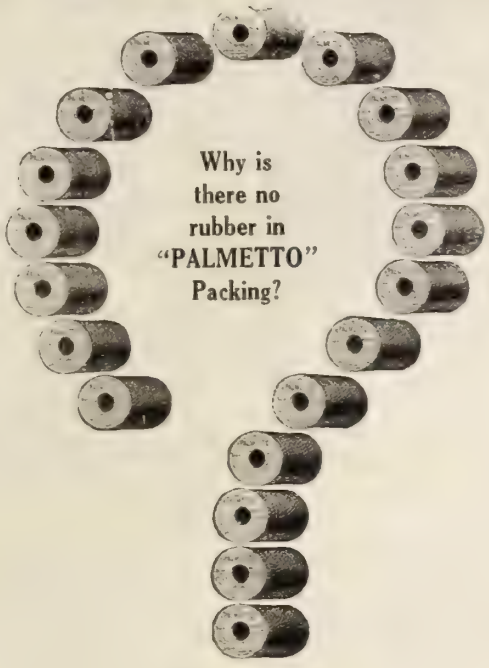
FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT



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because rubber quickly vulcanizes under the extreme heat of present day pressures, and not only fails to give the intended resilience, but is harmful to the packing itself.

Many years ago when steam pressures were so low as to carry practically no great amount of heat, rubber in packing served a useful purpose. But it has no place in packings for present day high pressures, especially where superheated steam and compressed air is used—**then why use a packing containing rubber?**

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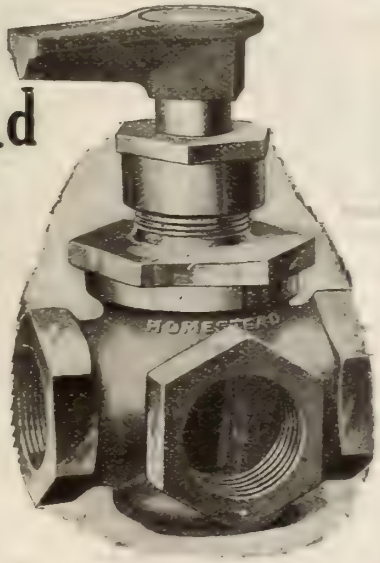

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Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

GRATE BARS FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. R. Sexton Boiler Setting Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co.
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
J. H. Williams & Co., Brooklyn, N.Y.
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

HOSE, COTTON
Garlock Packing Co., Hamilton, Ont.

HOSE, RUBBER
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
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Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

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Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton

HYDRAULIC MACHINERY
Bovine Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
MacGovern & Co., Inc., Montreal, Que.

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Bovine Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamison Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Johns-Manville Co. Ltd., Toronto.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

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Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Canadian Johns-Manville Co. Ltd., Toronto.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

LACE LEATHERS
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATING OIL FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon.

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Can. Mead-Morrison Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

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Mueller Mfg. Co., Ltd., The.

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Babcock & Wilcox, Ltd., Montreal.
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Sanford Riley Stoker Co., Worcester, Mass.
Maclean Underfeed Stoker Co., Toronto, Ont.

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Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

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The Bailey Meter Co., Cleveland.
Can. H. W. Johns-Manville Co., Toronto

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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
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Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
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Sturtevant Co., Ltd., B. F., Galt, Ont

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Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
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Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
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Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

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Flexible Metallic Packing Co., Windsor, Ont.
S. F. Bowser Co., Ltd., Toronto, Ont.

PACKING, OIL
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

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Shell Bar Boico Supply, Ltd., Toronto, Ont.

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Wm. B. Scaife & Sons, Pittsburgh, Pa.

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York Mfg. Co., York, Pa.

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Page-Hersey Tubes, Ltd., Toronto, Ont.

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Waterous Engine Works Co., Brantford.

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Taylor Instrument Co., Toronto, Ont.

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Frick Co., Waynesboro, Franklin Co., Pa.

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Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
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Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

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American Steam Pump Co., Battle Creek.
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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

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Smart-Turner Machine Co., Hamilton.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

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Smart Turner Co., Hamilton, Ont.
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The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Laurie & Lamb, Montreal.
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Pratt & Cady, Hartford, Conn.

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The John H. McGowan & Co., Cincinnati, Ohio.
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Smart-Turner Machine Co., Hamilton.

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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
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Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.

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Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
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Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

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Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
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Taylor Instrument Co., Toronto, Ont.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

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The Superheater Co., Ltd., Montreal.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Toronto, Ont.

REGULATING VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

RETORTS
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Can. Link-Belt Co., Toronto, Ont.

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Baldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto Toronto.

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Laurie & Lamb, Montreal.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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Canadian Planet Engineering Co., Ltd., Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
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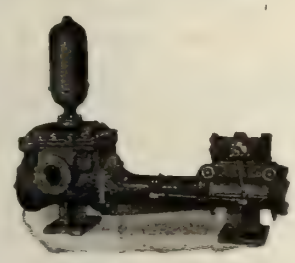
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.

PUMPS

The way in which the people of Hama get their drinking water.

The Syrian City of Hama is known for its large and ancient waterwheels, which supply the city and fields above with water. The wheel illustrated here is one of the largest of its kind in the world. It has a diameter of 70 feet, and is constructed of fine mahogany wood.



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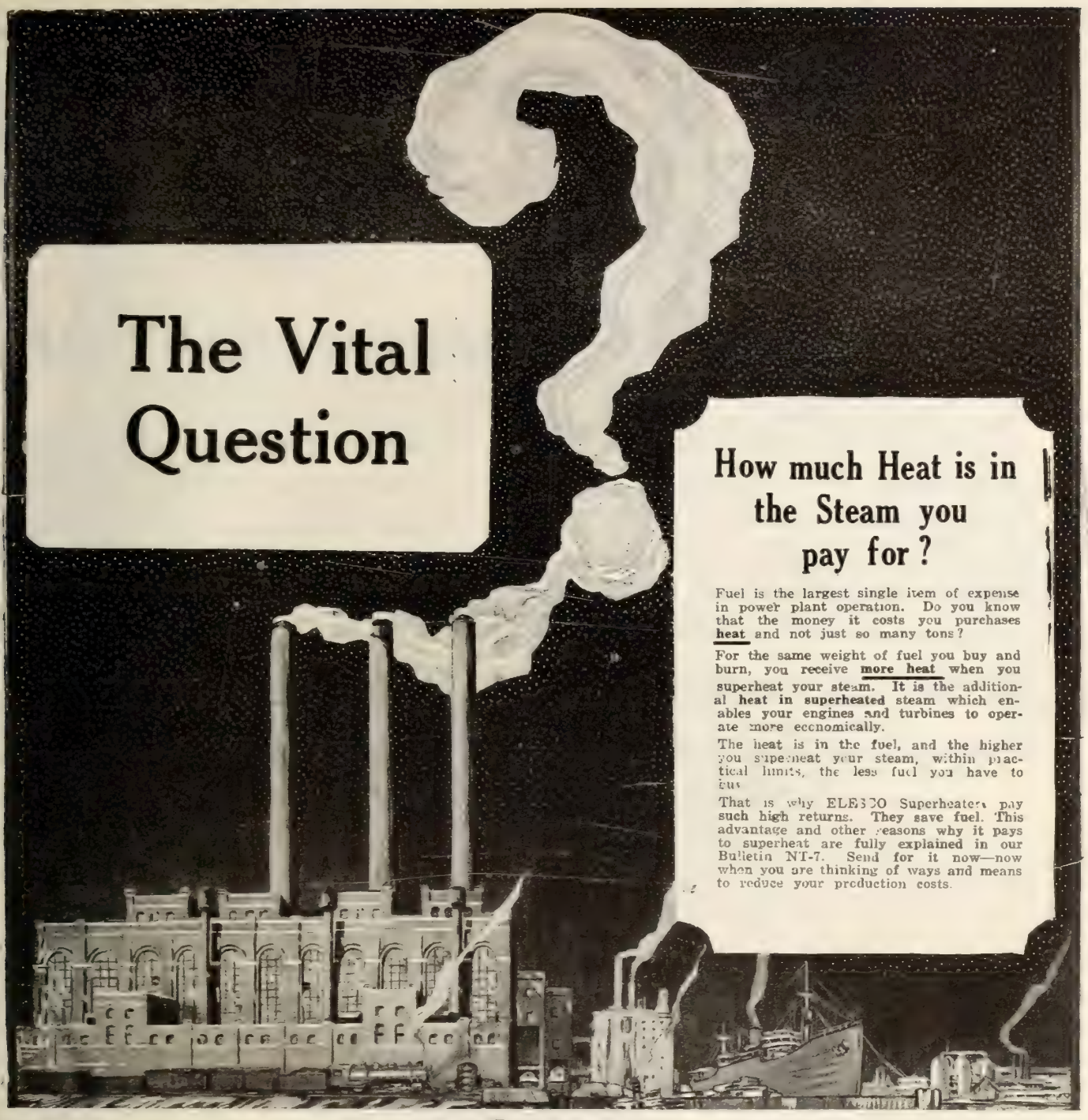
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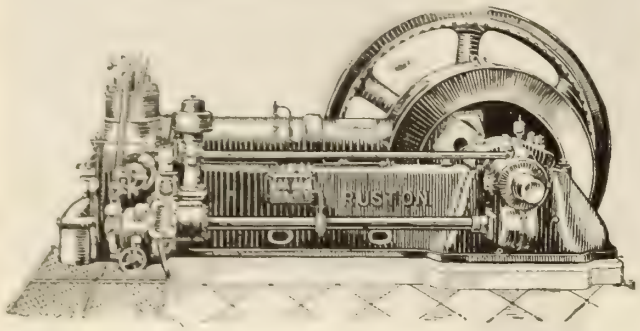

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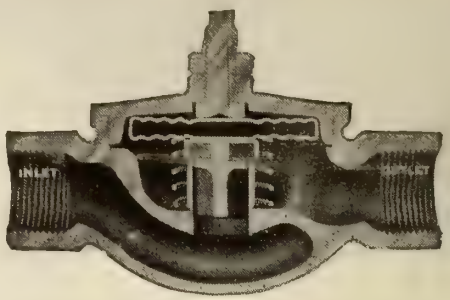

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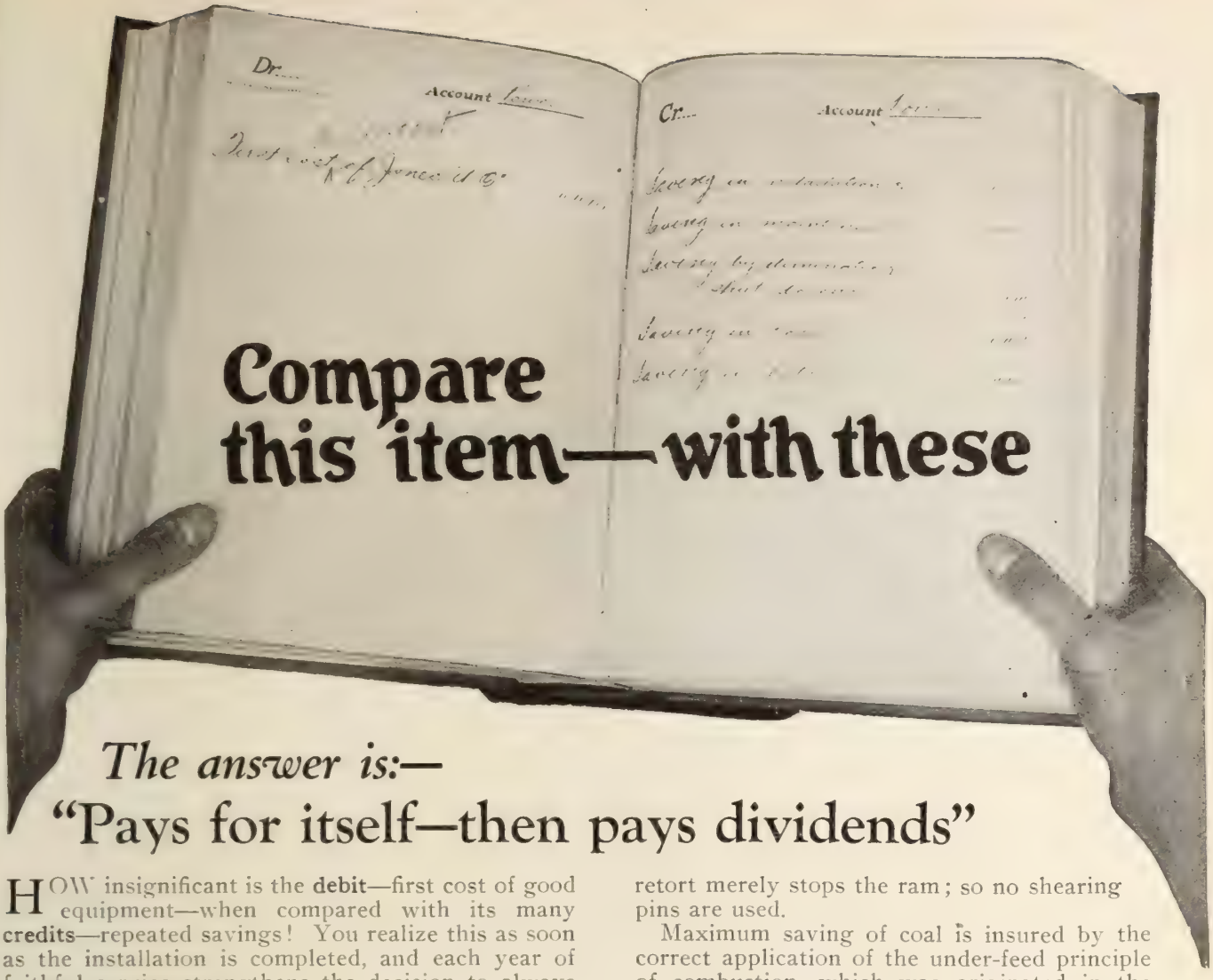

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More than 50 years of engineering experience is back of the Morrison Reducing Valve design.

Morrison Reducing Valves are furnished in all sizes with bronze or iron bodies for all ranges of pressure up to 300 lbs.

"Every Installation is a Demonstration of Merit."

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POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

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Vol. XV.—No. 6 — Publication Office, Toronto—March 20, 1922 — Published Semi-Monthly Canada, $2; U.S. $2.50 a year

AEROPLANE VIEW OF "HIS MASTER'S VOICE" PLANT, ST. HENRI, MONTREAL

They Needed Dependable Valves So They Installed "Jenkins"

When Jenkins Valves go in valve troubles go out—for good.

Dependability is built into every valve with the Jenkins name and the Jenkins Trade Mark.

The Berliner Gramophone Company's plant, illustrated above, is but one of the many big industrial concerns in which Jenkins Diamond Marked Valves are functioning satisfactorily day after day.

At Supply Houses Everywhere.

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LIMITED

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The Canadian Fairbanks-Morse Company, Limited, represents the leading manufacturers in every line it handles.

Fairbanks-Morse products--scales, valves, engines, motors, generators, pumps and railway equipment—have themselves set a standard of quality that is everywhere recognized.

When you require the leading makes of machinery and machine supplies, you look to the Canadian Fairbanks-Morse Catalog, and the nearest Sales Office, to meet your exact requirements.

The following Departments, under the supervision of thoroughly experienced men, are organized to render you intelligent service.

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Files Hand Stokers Getting Results

PANTHER RUBBER COMPANY, LIMITED

GENERAL OFFICES AND FACTORIES
SHERBROOKE, QUE.

Ans'd Sept. 26/21.

SHERBROOKE, CANADA September 23, 1921.

The Waterous Engine Works Co. Ltd.,
Brantford, Ont.

Gentlemen:

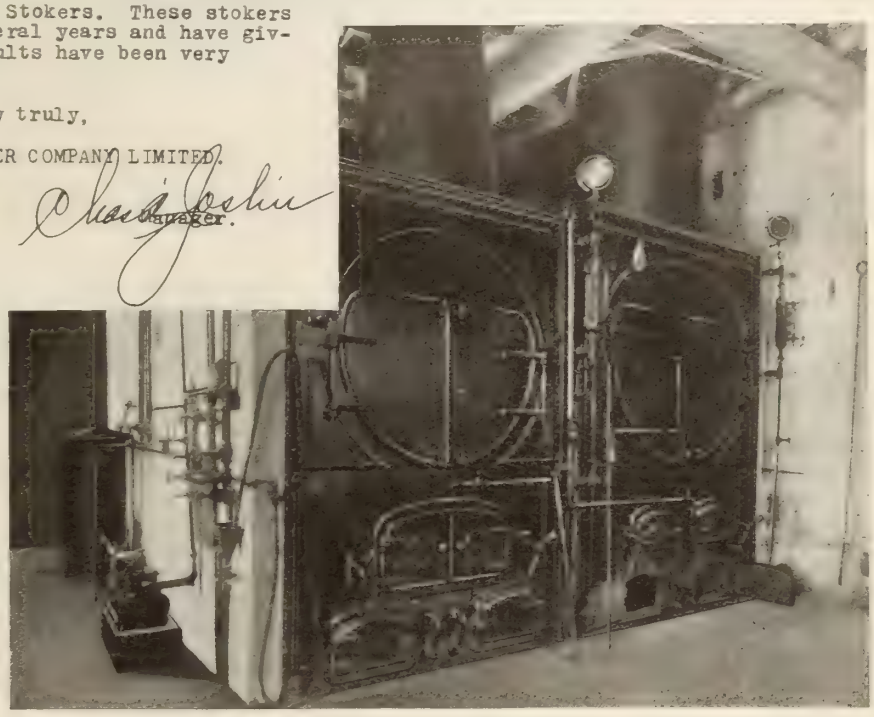
In reply to your letter of the 8th instant we have in our plant the Files Stokers. These stokers have been in operation for several years and have given excellent service. The results have been very satisfactory.

Yours very truly,

PANTHER RUBBER COMPANY LIMITED.

Chas. A. Joslin
Manager.

CAJ/RMK



It is the uniform excellent service and general satisfaction that have caused progressive men to select **Files Stokers.** These are typical of the more complete data we have compiled:

One installation (3,600 H.P.) saved enough coal to pay for their stoker investment in five months.

A Files installation operated for five months continuously at an average rating of 223%—doubling their steam output.

Files stokers increased efficiency of one plant sufficiently high to warrant discontinuance of two out of eight boilers.

Here is a ready explanation of these achievements:—

1. **Complete volatilization of green coal, causing intensified combustion and smoke dissemination.**
2. **Correct distribution and proper proportion of air according to load carried**
3. **Fuel bed continuously kept clean, uniform and rich.**

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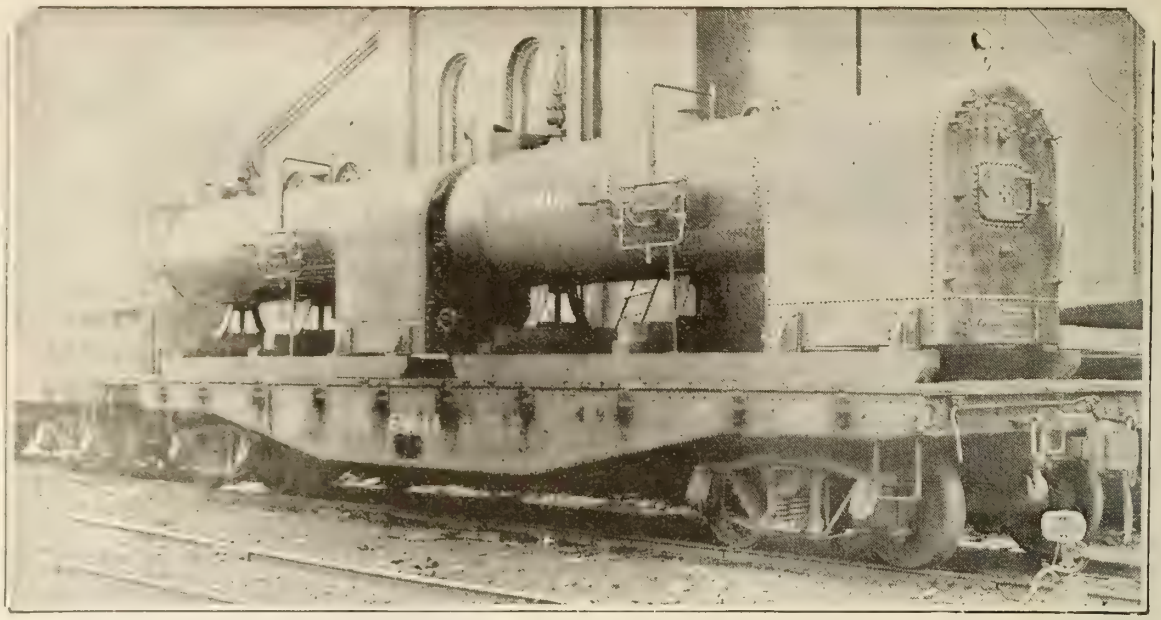

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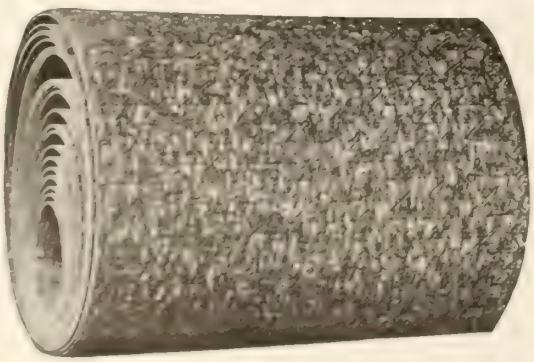

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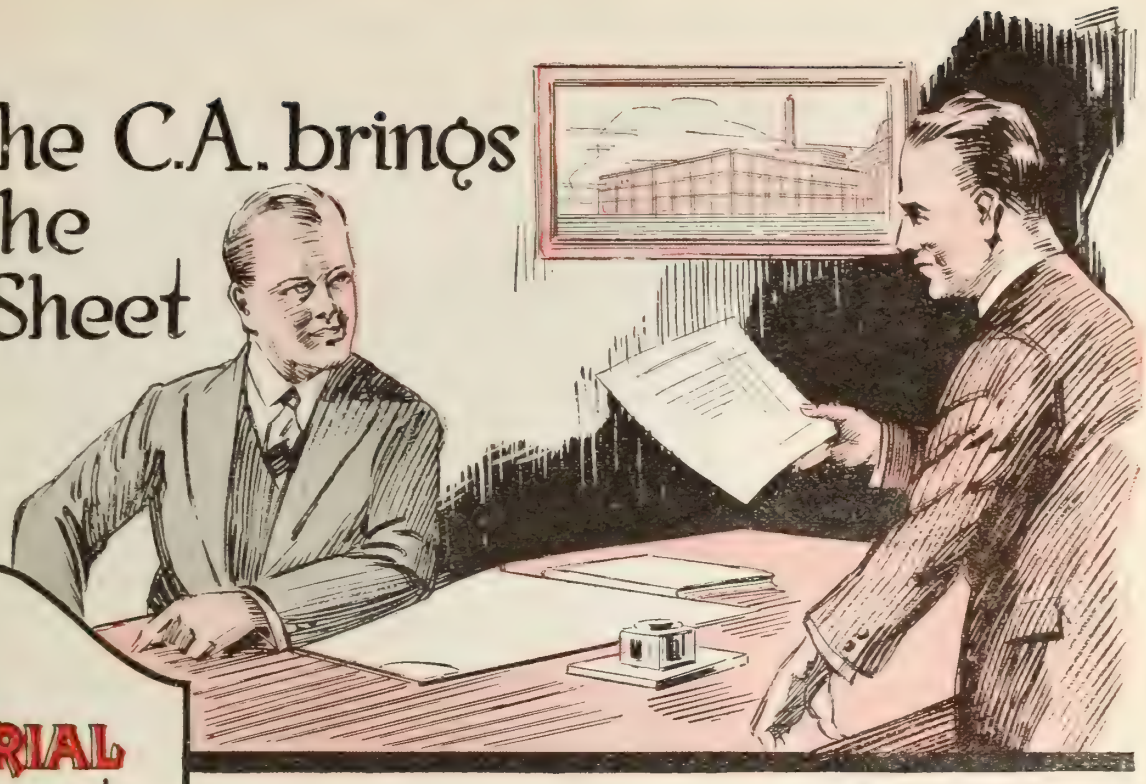

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The Cost Accountant's figures indisputably prove that Imperial Lubricants are a big factor in reducing plant maintenance and upkeep costs. On one item alone—depreciation—they often save their cost several times over.

Machinery ***wears less*** and ***lasts longer*** when every journal, bearing and shafting is correctly lubricated with Imperial Lubricants. The varied line listed at the left includes a high quality oil or grease for every lubrication requirement. The use of the right grade assures smooth, steady-running plant units.

For details regarding the expert service of Imperial Lubrication Engineers, write to 56 Church St., Toronto.

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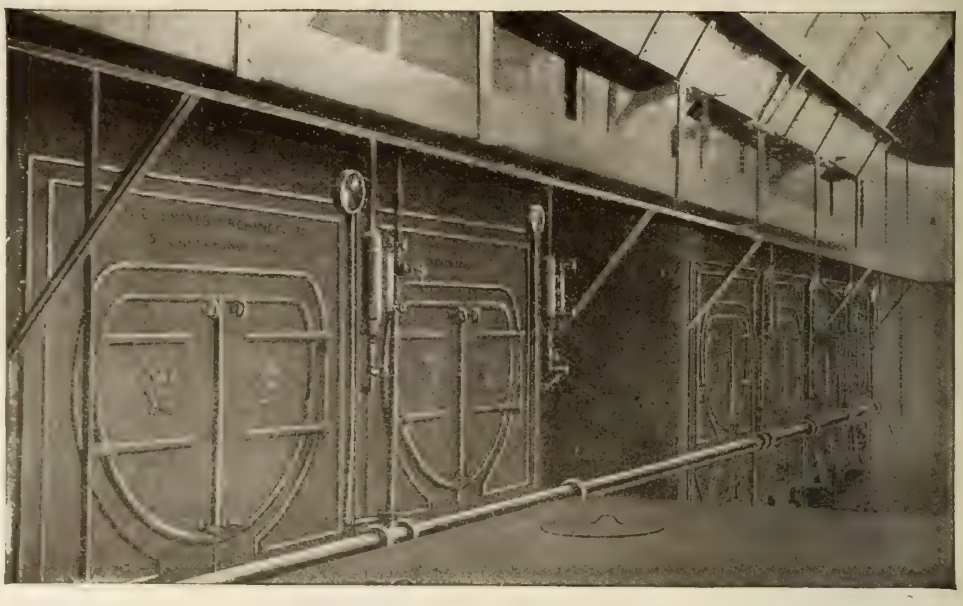
Buy what you need NOW!

This is the doctrine that if practised will start the wheels of industry humming all over Canada.

Just now we can give you exceptional service and prices on new, modern, highly efficient boilers — of any type, in any size.



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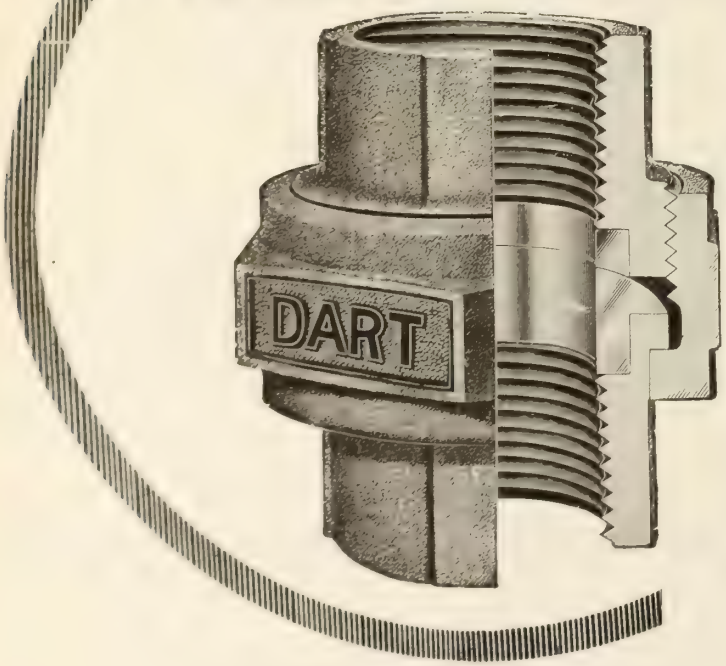

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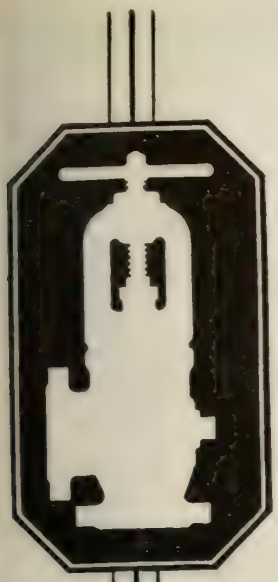

LUNKENHEIMER
"Duro" Blow-off Valves

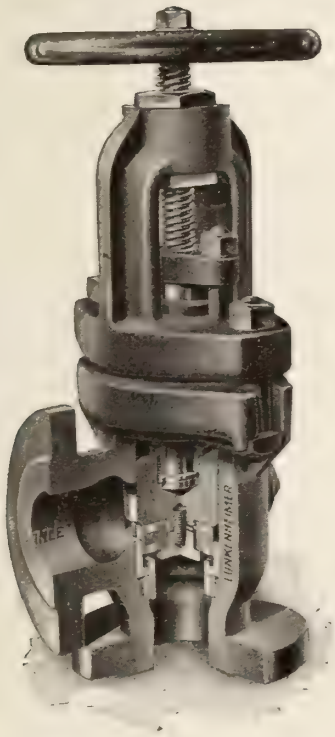

Fig. 897, Flange Ends.
Fig. 896, Screw Ends.

"Duro" Blow-off Valves prevent heat waste in blow-off lines. They remain tight under extreme operating conditions because they are not only made of wear resisting materials, but their design is such that the usual causes of leakage are eliminated.

The piston shaped disc secures a gradual release of the water due to its travel in the cylinder above the seat before full open position is reached. And when closing, the seating surfaces are automatically cleansed by the fine stream of water forced past the disc as it travels through the cylinder casing before seating. This action also minimizes wire drawing of the seat.

"Duro" Blow-off Valves contribute to efficiency and economy in plant operation and meet every blow-off requirement. Sizes 1¼ to 3 inches, in Iron Body Bronze Mounted Pattern for pressures up to 250 pounds.

Specify "DURO" BLOW-OFF VALVES and insist on their installation.

Write for Catalog 58-DC

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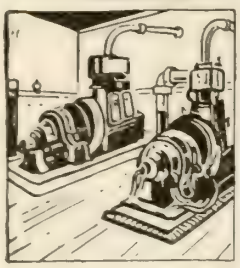

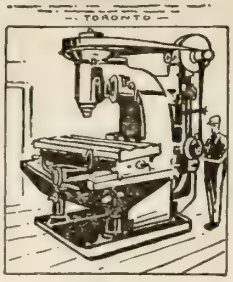

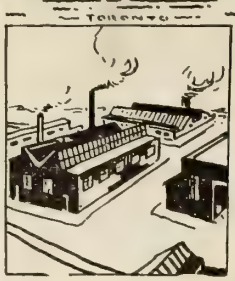

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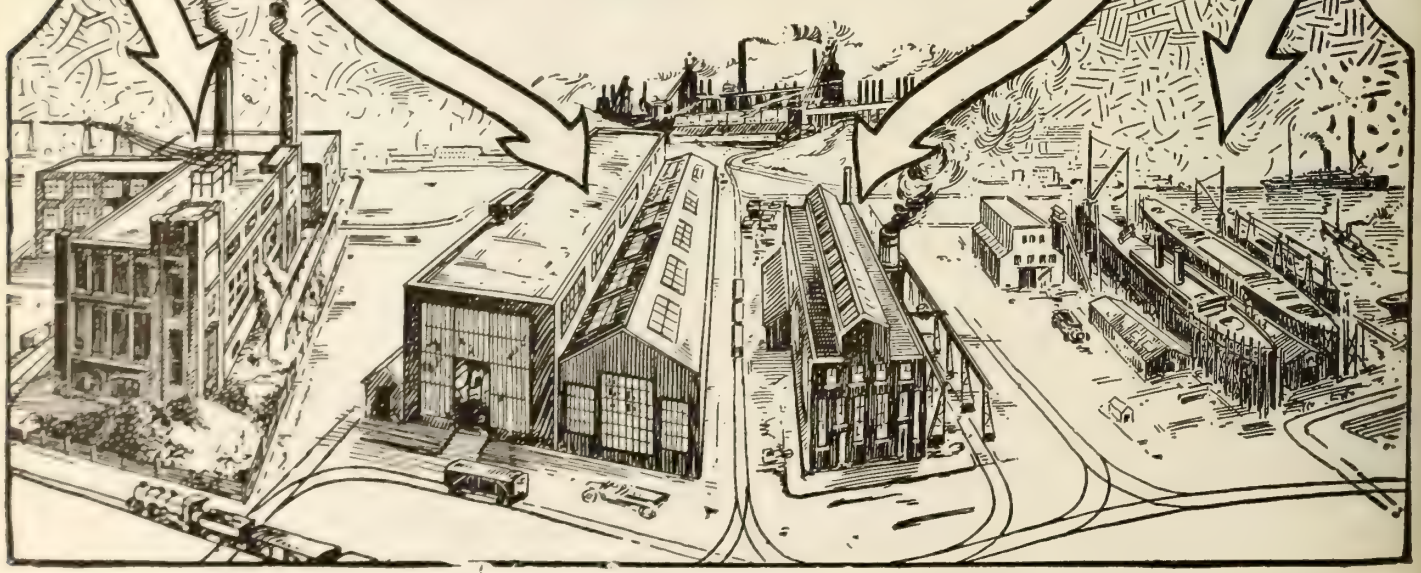

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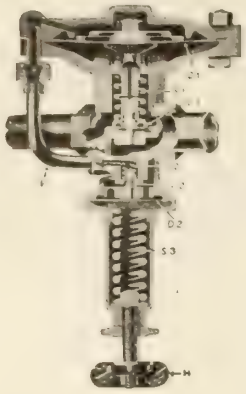

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Unguarded steam disappears. It has no value. Once gone, it is gone forever.

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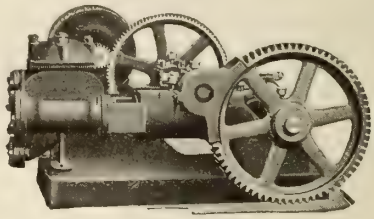


FIG. 7404

POWER PUMPS

Made in piston and outside center packed plunger pumps for both top and side motor mounting.

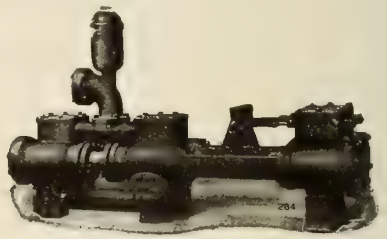


FIG. 7284

BOILER FEED AND GENERAL SERVICE PUMPS

Direct Acting Steam Pumps for All Conditions of Service and for All Industrial and Public Utility Purposes.

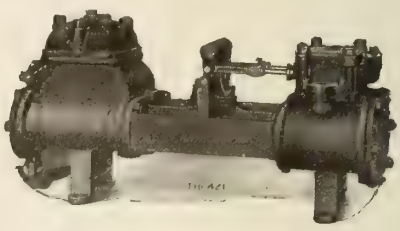
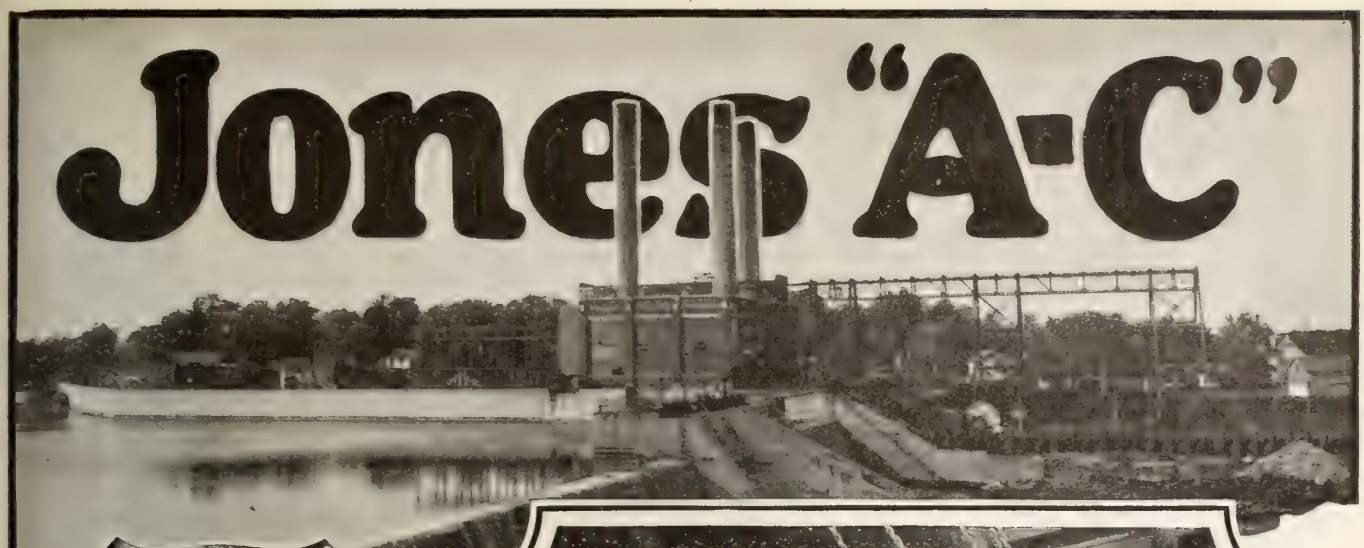


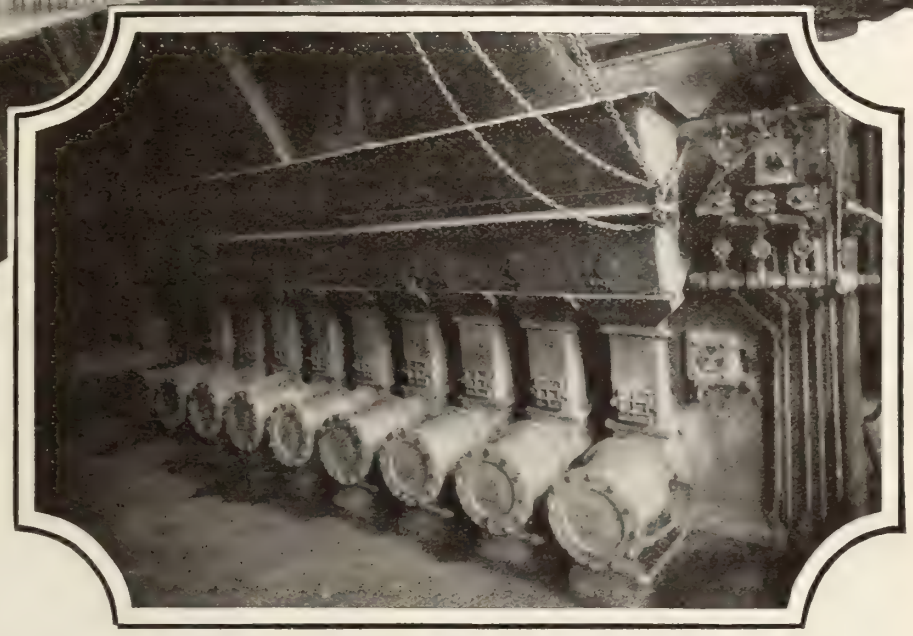
FIG. 7295

PACKED PISTON BOILER FEED PUMP
Established 1852

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

Jones "A-C"





Jones "A-C" Stokers used in connection with hydro-electric development. The same stoker that is giving excellent results in large plants is also ideal for small plants. The saving is even more gratifying.

The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. Through special arrangement the extensive engineering resources of the Under-Feed Stoker Co., of America are made available for Canadian power users. Thus, this strictly Canadian stoker is backed by world-wide experience and unequalled engineering ability.

Since Hand Firing Won't Do Install a Real High-Duty Stoker

Too many stokers are merely substitutes for hand firing. By eliminating the waste of hand firing they effect economy—but not as great economy as is possible through **real** high-duty stoker firing. Small plants as well as large plants, to-day regard a stoker as a means of **economy** instead of an expense. First cost is considered only in relation to the dividend it yields.

The Jones "A-C" has proved its ability as a dividend producer by perfectly fulfilling the rigid requirements of high-duty stoking.

Its extreme simplicity—only one moving part, none in the fire—reduces maintenance and practically eliminates shut-downs.

The under-feed principle of combustion—a principle originated in Jones Stoker—provides maximum combustion efficiency, ability to burn poor grades of coal, and heavy overload capacity.

The automatic-cleaning feature and special tuyere construction overcome objectionable formation of clinkers on front, side and bridge walls. Automatic control of fuel and air insures even steam pressure under widely varying load demands.

What single investment will yield as great return as high-duty stoker firing?

The new Jones "A-C" Catalog explains this new coal and labor saver in detail. Ask for a copy.

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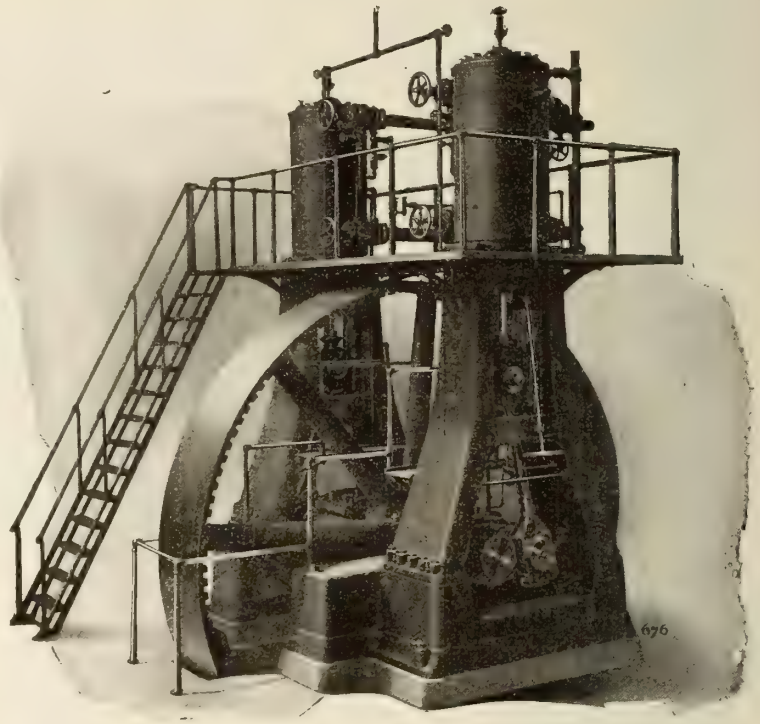
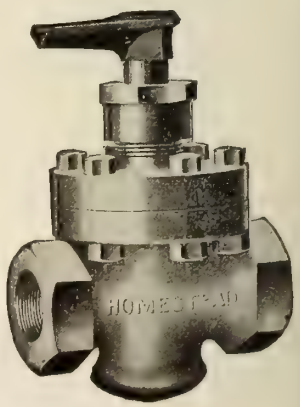


Direct and Unrestrained Flow
With Simplicity and Durability
Features of HOMESTEAD VALVES

The harder the service the more you need **Homestead Quarter-Turn Valves.** They always stay tight—because of their seatless construction. For safety, reliability, tightness under all conditions, and simplicity in operation, Homestead Quarter-Turn Valves are unequalled. Made in straightway, threeway and fourway patterns; the illustration shows the straightway style. **Write for valve catalog.**



HOMESTEAD VALVE Mfg. Co., Homestead, Pa.
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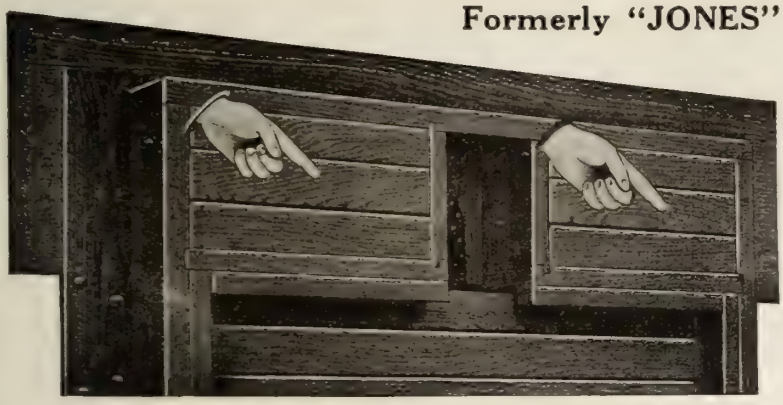
Formerly "JONES"

Heavy Duty Cold Storage Doors



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Note the back of our Standard Track Head Frame with track part; we insulate and finish our track frame heads, an unusual feature. Then note the simplicity of the Track Lift device over the door; no springs or other delicate parts to get out of order. Our Automatic Self-tightening Fastener draws the door rigidly tight each time it is slammed. The hinges too are three to five times heavier than other makes.

These features, and many others, are fully explained in catalog No. 10. Write for it.

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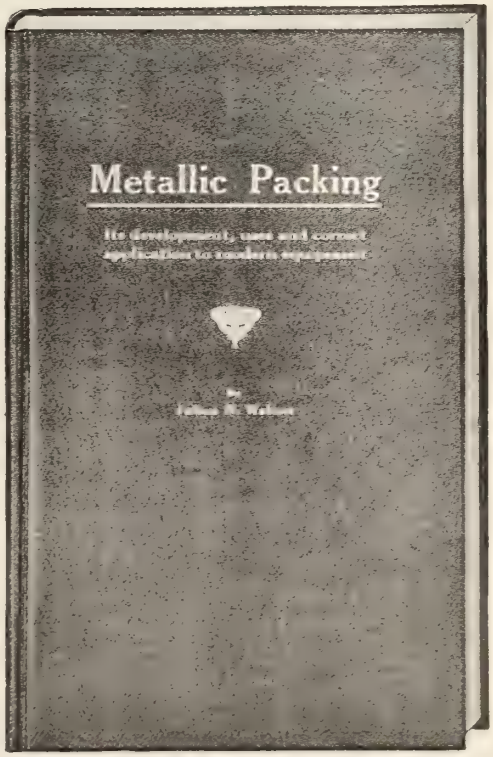

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All working parts are above water—not damaged by rust and very accessible.

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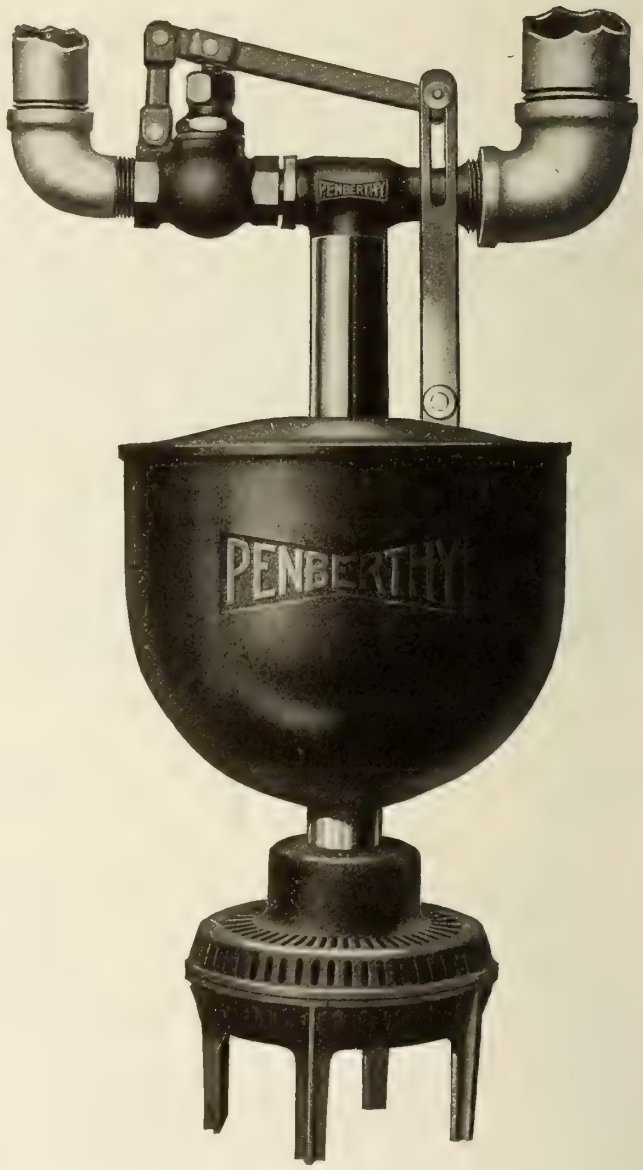

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Manufacturers of

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Prevents Power Interruptions

Burning all classes of bituminous coal efficiently and maintaining a constant uniform steam pressure is the way MACLEAN UNDERFEED STOKERS take care of your steam requirements day in and day out, regardless of varying loads on the boilers.

The MACLEAN STOKER adjusts the coal feed and air supply automatically responding to sudden demands for steam without attention from the fireman.

It is easy to install—easy to operate; small cost of upkeep; no moving parts in the fire. Along with these and other advantages the MACLEAN STOKER makes savings that will soon pay for its installation.

May we estimate the saving to be made in your plant? You are under no obligation to purchase.

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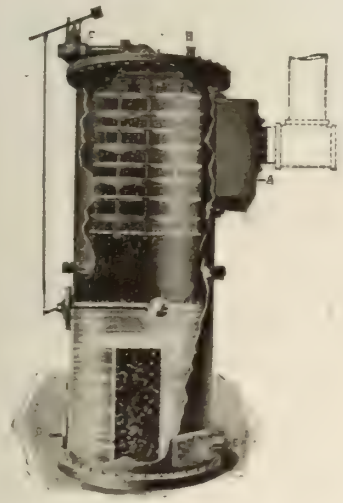

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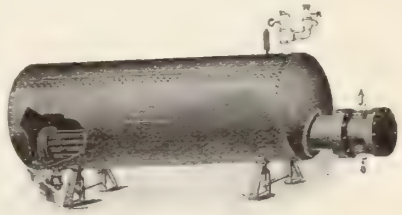

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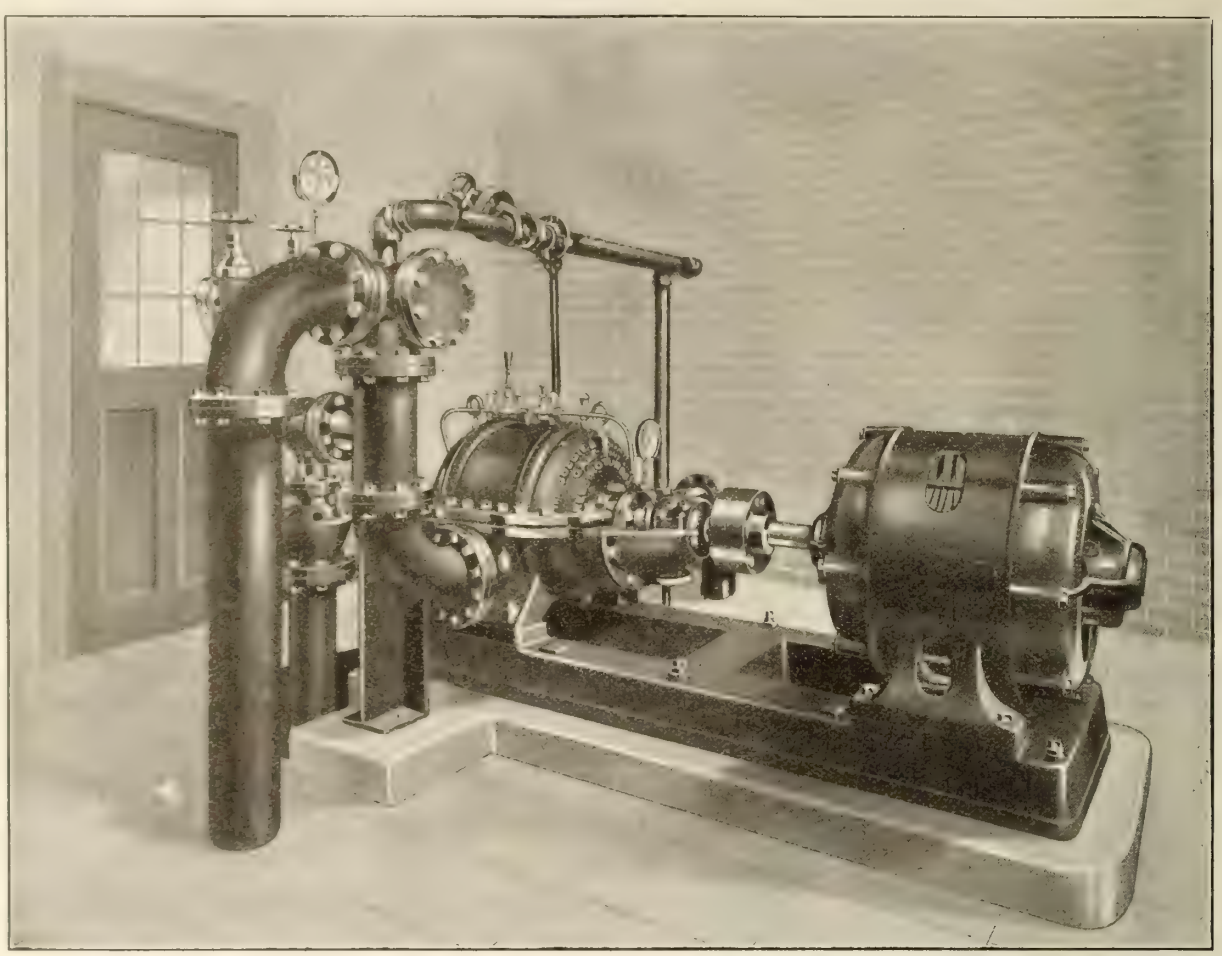

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The Power Plant Journal of Canada

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The Main Plant of the Montreal Street Railway

This Central Station, Containing Twenty-Two Water Tube Boilers, Turbo Generators, Direct Connected Reciprocating Units of Large Size, and All the Auxiliaries That Pertain to These Units, is a Sight Worth While

By T. H. FENNER

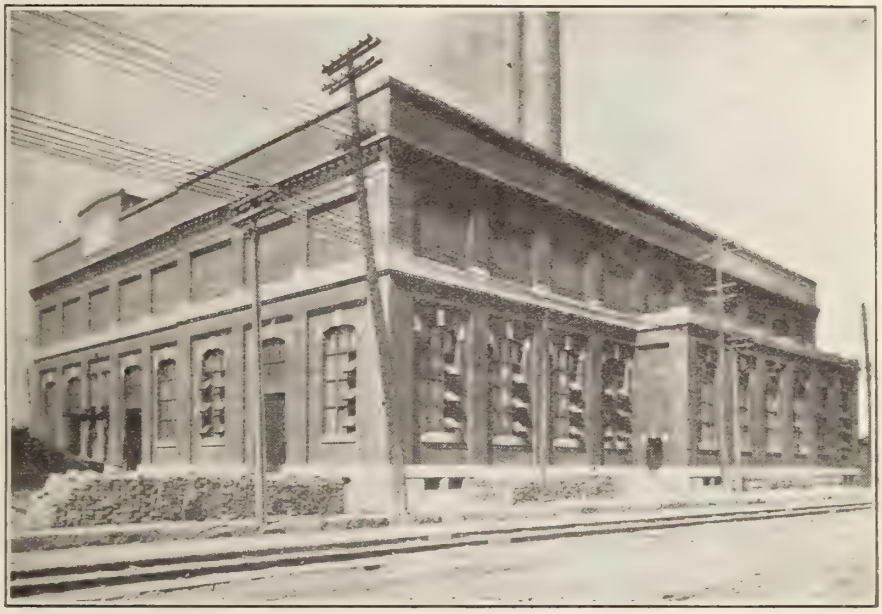
WHILE we are accustomed to hearing of central electric power and lighting stations of high powers driven by steam, they are usually situated in the United States, and one gets in the habit of associating all these big developments with that country. We do not have to go out of Canada, to find some examples of these large developments, and one of the best examples, and probably the largest, is the central plant of the Montreal Street Railway, at Hochelaga.

The station supplies the current for the whole tramway system of the huge city, delivering direct to the trolley wires from some of its units, and feeding out over high tension cables to the sub stations placed around the city at different points, with others. The station, while contained in one building, represents two different styles of practice in developing electric power, and is the more interesting for that reason. One end of the building is devoted to d. c. generation, while the other is sacred to the a. c. method. One sees the huge vertical cross compound direct connected engines of comparatively slow speed, in juxtaposition to the compact high speed and high powered turbines, and the relation between power and speed is forcibly impressed on one. This is particularly the case when looking down from the top platform of the three thousand k. w. McIntosh Seymour engine, which towers up at an impressive distance from the floor, at the 2,000 k. w. Bellis & Morcom turbo generator, which looks very tiny in comparison to its big neighbor.

The outside view of the building gives some idea of its general dimensions, although it fails to convey any impression of the depth to, which it goes underground. The illustration of the boiler, taken from the sub-basement shows the full height of the station to good advantage.

The General Arrangement

The building is divided into three floors, and is also divided longitudinally by a wall running down the centre of the building. The main floor on the south side of the wall is devoted to the turbo generators, steam engines, rotary converter, and the switchboard and offices. On the north side of the dividing wall on the ground floor, or main floor are the boilers. The engine room basement contains at the west end the pumping arrangements for the barometric condensers of the vertical engines and the workshop is also situated here. At the east end of the power house in basement and sub-basement are the circulating pumps, condensers, feed pumps, and heaters in connection with the a. c. side of the plant.



The Hochelaga Power House of the Montreal Street Railway

The basement in the boiler room is devoted to the ash-handling and coal-conveying arrangements, which include coal crushers at each end of the boiler room. The boiler room itself is divided into what is known as the high and low pressure side, the high pressure side supplying the alternating current generators and their auxiliaries, while the low pressure side is devoted to the d. c. current generators.

The foregoing having served the purpose of giving the reader a general idea of the arrangement of the plant, we can now consider the various units in greater detail.

The Boiler Installation

The boiler installation in total consists of twenty-two Babcock & Wilcox water tube boilers, both the cross drum and longitudinal drum type being used. The low pressure side, as the boiler installation supplying the reciprocating engines is called, consists of fourteen 550 rated h. p. two drum boilers, working at 150 lbs. pressure per square inch, with 70 deg. superheat, and fitted with Green economisers. These economisers are situated above the boilers in this case instead of the familiar method of placing them behind the boilers. This of course was due to consideration of space, and does not affect the efficiency in any way, the length of flue from boiler to economiser being about the same, or but little longer than in the ordinary arrangement.

Each boiler is fitted with the Babcock & Wilcox chain grate, and the coal is supplied to the hoppers through a Jeffries traveling automatic weigher. The conveyors we will come to later. Each boiler is fitted with an injector as well as the pump feed, in case of emergency. The feed arrangement consists of two Cochrane heaters delivering to Fairbanks duplex feed pumps in inches diameter by 18 inches stroke.

The economiser installation for this battery is divided into four economisers, each having a heating surface of 7,650 square feet. These economisers have the tubes arranged in sections ten tubes wide, there being sixty sections in each economiser. The tubes are nine feet long, and 4-9 16ths inches outside diameter.

The average increase in temperature of the feed water passing through the economisers is 80 degrees, and this results in an increase of about 7 per cent. in the overall efficiency of the boilers and furnaces. The increase in capacity of the boilers due to the use of the economisers is also 7 per cent. The power required to operate the economiser is only about 10 horse power, so that it can be readily seen that here is a case where the investment is well worth while. With an average flow through the economisers of 70,000 lbs. per hour and an average increase in temperature of 80 deg., there is a saving of 5,600,000 B. t. u. per hour. If the coal has a heat value as fired of 10,000 B. t. u. per lb. there is a direct saving of 560 lbs. per hour, or if a boiler horse power is taken at 34,500 B. t. u. there is the heat equivalent of about 160 horse power.

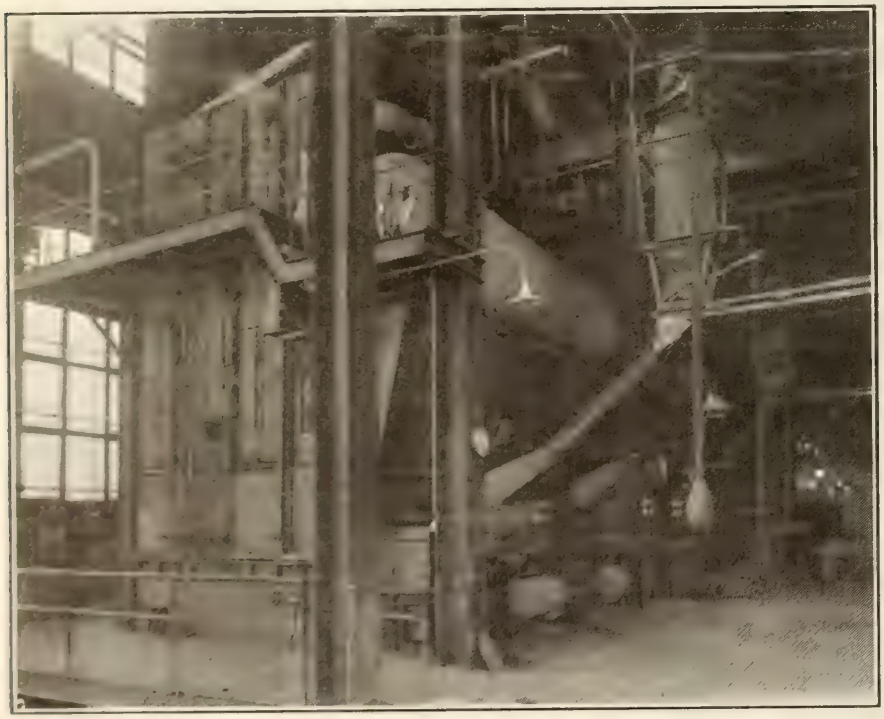
These figures are of course only approximations, but they show in some measure what influence the economiser has in the operation of a steam plant of average size. There is also the point to consider that these economisers constitute a large reservoir of heat, which is available for sudden emergencies such as are liable to arise in the operation of a street railway system.

View in boiler room showing chain grate stokers and coal chutes.

The stack for this battery is 235 feet high with a diameter of 12 feet, and the normal draught at its base is 1 inch water gauge. There is also an installation of induced draught fans for use when required.

Passing from the low pressure boilers, which are of course only low pressure in comparison with the others, we come to a battery of four 550 horse power boilers working at 200 lbs. per square inch, supplying steam for the a. c. turbo generator sets. These boilers work at a superheat of 190 deg., and are fitted with superimposed economisers with steel tubes.

There are still further four cross drum marine type boilers of 1,100 h. p. each working at the same pressure and temperature and these eight boilers constitute the high pressure side of the installation. All these boilers are fitted with precision draft gauges of the differential type, and also General Electric flow meters. There is a "Sarco" CO_2 recorder in the engine room connected with the flue gases from these boilers. The stacks for these boilers are of the Evase type, which operate on the ejector principle of inducing draught. There is a complete installation of Diamond Soot Blowers on boiler and economiser.



View of one of the 1,100 H.P. Boilers with superimposed economiser, and automatic travelling weigher in front

The Conveying Arrangements

The coal is brought into the yard, and there is a general storage capacity of about 30,000 tons available here. The coal is brought into the yards by cart, and is distributed and reclaimed by means of portable elevators. When ready for use it is dumped into hoppers at each end of the boiler room, and delivered by a chute into the coal crushers. The coal crusher at the low pressure end, or the west end of the boiler room, is a Babcock & Wilcox double roll crusher, capable of handling 45 tons of coal per hour. This crusher breaks the coal up into lumps about ¾ inch square, which is a suitable size for the chain grates. From the crusher the coal is taken away by a bucket conveyor, which travels through the basement practically the whole length of the low pressure battery, then goes up to the overhead bunker which has a capacity of 1,600 tons, travels the whole length of this bunker and then down again to the coal crusher. There are of course spilling arrangements for the buckets in the conveyor

A view showing the arrangement of the ash hoppers under the boilers, with the truck standing under the hopper. The small riddling hopper can be seen at the left of the truck

path in the bunker, so that an even distribution can be made. The coal from the bunker runs by gravity into the traveling weigher, and thence is directed into the hopper of any particular boiler where it may be required.

For the high pressure end of the installation there is similar arrangement, the bunker capacity at this end being 1,000 tons, the coal crusher being situat-at the east end of the boiler room in this case.

Thus far the coal conveying arrangement. After the coal has performed its function in the furnace the residue has to be got rid of, and we must go down the basement below the firing floor to see the arrangements for doing this.

The ashes from the end of the chain grate are delivered into a chute on the end of which there is a hopper, situated in the space under the boiler ashpit. There is one of these chutes and hoppers directly under each grate, and there is also another chute connected with the ashpit, and known as the riddling hopper. This is for handling the droppings from the chain grate which contains a certain percentage of unburnt carbon. This is of course kept separate from the main ash chute.

Along the basement floor runs a trolley rack which passes in front of all the chutes, and runs to the far end of the boiler room, or rather we should say the east end. Here there is a hopper, communicating with a bucket conveyor, which takes the ashes up into an overhead hopper from whence they can be loaded into carts and taken away.

The illustration herewith gives a good idea of the arrangement as described above. The coal consumption is about 300 tons per day during the year. On the same floor under the boilers are situated the engines for driving the chain grates. There are four of these, and they are so arranged that they can be connected to any of the stokers, so that there is no possibility of a shut down through engine trouble. Each engine is in a recess formed in the boiler foundation, so that there is nothing in the way. They drive the stoker shafts through a belt.

As a general rule there are from ten to eleven of the 150 lb. per square inch boilers on the line, while there are six of the high pressure side working at a time. The others are of course down for cleaning, or on the standby. Some of the boilers which are actually on the line will be banked for a portion of the time, a tramway load being of course a very fluctuating quantity. The peak periods in Montreal are pretty much the same as in any big city, and lasting from about five in the morning till eleven, and again from four o'clock till seven, with another partial peak in the evening when the theatre crowds are going down town and later coming home.

Climatic conditions make a difference in the load at times, as they affect the state of the rails. A good clean wet rail will afford an excellent conducting material, and thus help matters out, while also giving a good grip to the wheels. When an icy slush covers the tracks both conditions for conducting and the grip of the wheels is bad, and the load thus increased. However, the central station crew develop a sort of sixth sense which tells them when demands are likely to be heavy, and it is unusual for them to be caught napping.

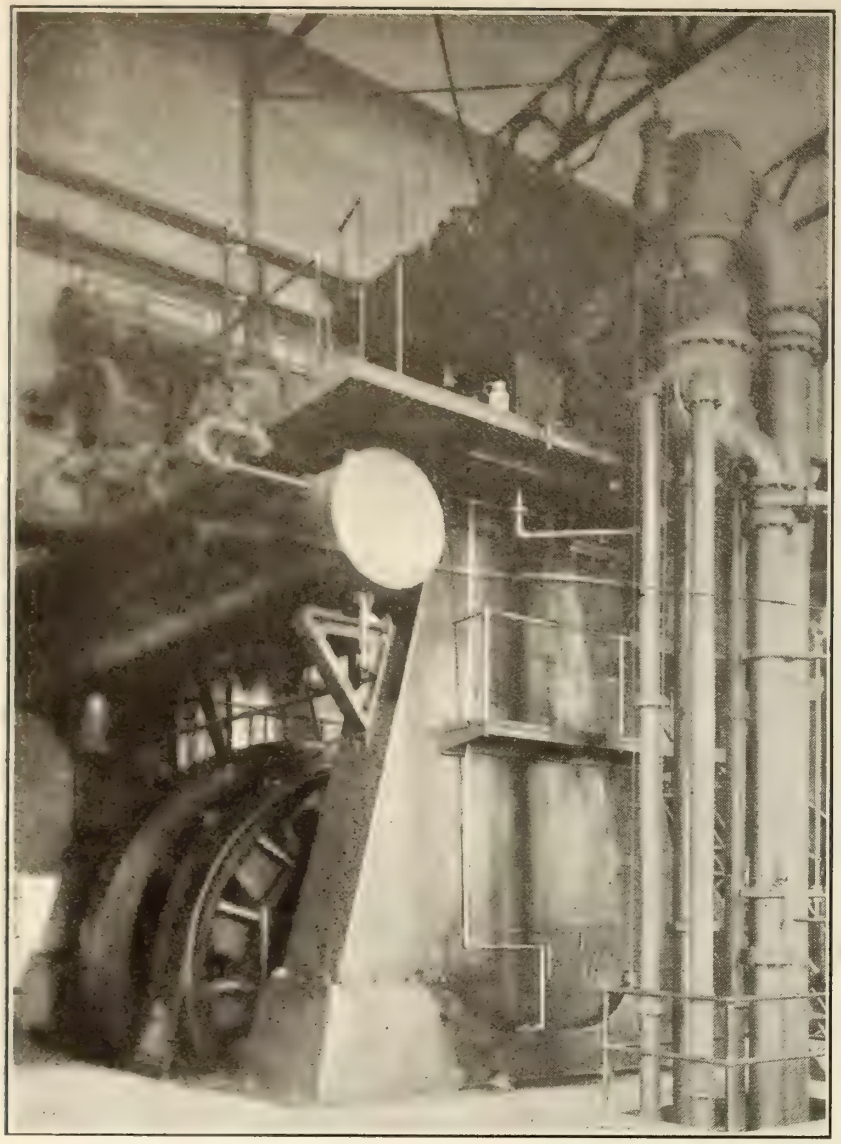
The Engine Room

The foregoing description, while it is perhaps inadequate to convey to the mind of the reader the extent of the installation, will be helped out by the photographs reproduced here, and we can go on to the engine room floor and describe in some detail the units situated up there. As we started with the low pressure battery of boilers we had better preserve the same order and start with the reciprocating units in the engine room. There are three of these, and they are all of the same type though not of the same size. The two smaller ones have cylinders of 26 inches high, and 54 inches low pressure, with a stroke of 48 inches. These two units are fitted with Westinghouse d. c. generators of 1,000 k. w. capacity, at 600 volts while the large unit has dimensions as follows: high pressure 35 inches, low pressure 72 inches with 54-inch stroke, fitted with General Electric Company d. c. generator of 3,000 k. w. capacity at 600 volts.

All these units are of the cross compound vertical type, the generators being fitted on the crank shaft between the two cylinders. They are all three fitted with barometric condensers, and work normally with a vacuum of about twenty-five inches at the condenser. There is a heater in the receiver between the high and low pressure cylinders, and the high pressure cylinder has steam supplied with a 70 deg. superheat.

The condensers are fitted with Blake dry vacuum pumps, the circulating pumps being situated in the pump room will be described later on.

The oil from these engines is taken down to filtering tanks in the basement and after being freed from impurities is pumped up into receiver tanks on the wall of the engine room, at a considerable height above the engines. One of these tanks can be seen in the illustration. The oil then flows from the tanks



View of McIntosh Seymour engine showing receiver between H. P. and L. P. cylinder and barometric condenser

to the various engine bearings by gravity, and the tanks are of sufficient capacity to contain a full day's supply for the engines. Thus a practically unlimited amount of oil under a good pressure is supplied to all the bearings. This is a very good feature and ensures good operating conditions.

It will be interesting to those who have not been in the habit of carrying out any large repairs to know that Mr. Wright, the genial chief engineer of the station, has at various times lifted the cylinders off these engines, deposited them on the engine room floor, and with a boring bar and the help of their own staff, rebored them. In most places they would be content with carrying on the ordinary duties of a plant this size but here they took on this little boring out job as a matter of course, and at a considerable saving to the company.

These three engines deliver direct current at 600 volts to the switchboard, whence it is distributed direct to the trolley wires within a certain radius of the power station. They are usually running in the winter months from 5 a.m. till 11 a.m. and again go on from four o'clock till about 7.

The 2,000 K. W. Turbo Generator.

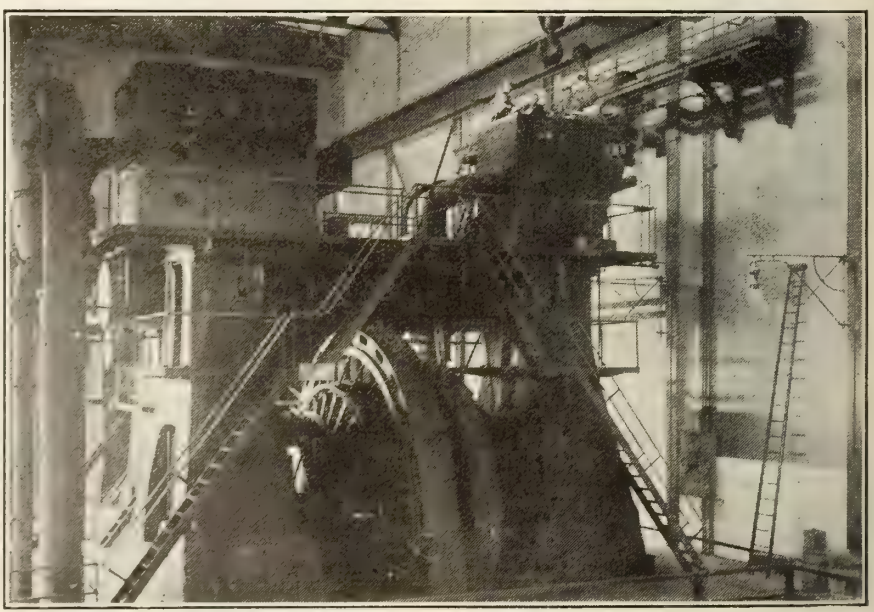
The two thousand kilo watt turbo generator which was shut down at the time of our visit, is a Bellis & Morcom impulse type turbine, direct connected to a Swedish General Electric Co. alternator of 2,000 k. w. capacity, at 2,300 volts. The condenser in connection with this unit is a Korting Multi Jet type, equipped with vacuum break, and not requiring any air pump.

There is also a small Bellis & Morcom high speed set direct connected to a d. c. generator for exciting purposes. This small unit can be seen against the wall in the illustration.

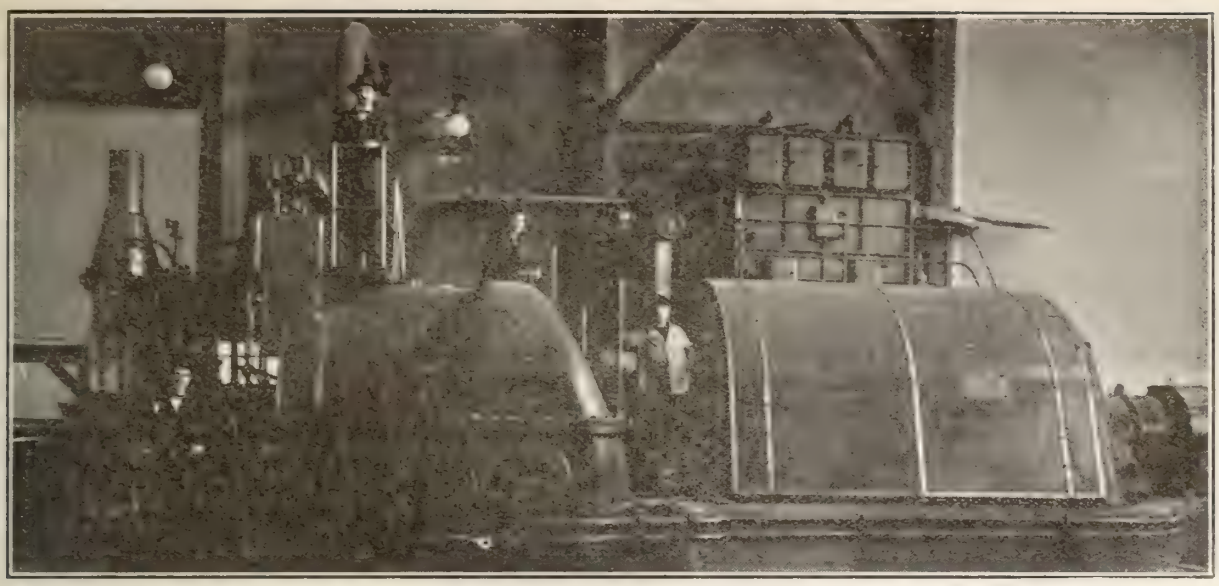
The turbine itself runs at 1,800 revolutions per minute, and is compounded for velocity at the first stage while at the second and subsequent stages it is compounded for pressure. The generator is of the revolving field, stationary armature type, and develops three phase, 60 cycle alternating current at 85 per cent. power factor, the voltage and capacity as given above.

This unit delivers power to the switch board, from whence it can be sent out to the sub-stations and used for driving the rotary converters there, or it can be delivered to the driving side of the rotary converter in the central station itself, and sent out to the trolley wires direct at 600 volts.

The ventilation of the generator, which is completely enclosed, is provided for by means of a fan fitted on the shaft, drawing air in at the bottom of the casing and discharging it at the top, after passing through the armature and field coils. The temperature rise in the windings is guaranteed not to exceed 40 deg. Centigrade after a run of 24 hours at full load, and with 25 per cent. overload for 24 hours, the temperature rise will not exceed 50 deg. Centigrade. These tem-



The 3000 K. W. McIntosh Seymour cross compound vertical engine with barometric condenser



The 12,500 K. W. Turbo Generator. The Webster feed heater can be seen behind the generator, and the cylinder of one of the Weir pumps behind the turbine

perature rises include the heat radiated from the turbine itself.

The circulating pump for this unit is a Bellis & Morcom low lift centrifugal pump, motor driven, capable of pumping 2,000 gallons per minute. The bearings of the turbine and generator are lubricated by forced feed from a pump fitted in the pedestal, and furnishing oil under a pressure of 40 lbs. per square inch to the bearings. The oil after going through the bearings is passed through a cooler before being again pumped up.

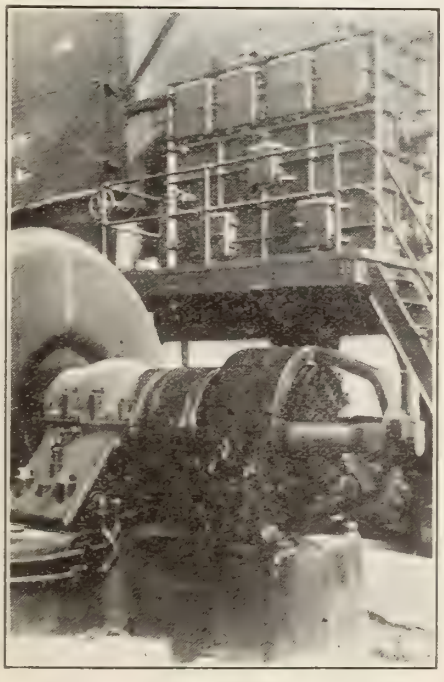
The main governor for the turbine is of the Bellis & Morcom centrifugal type, driven by worm gear from the main shaft. The emergency governor is quite separate from the main governor, and is fitted to the main shaft of the rotor. The governors operate relay oil systems, and the emergency governor is arranged so that it will close at a prescribed overspeed, or will also close if the oil pressure should fail, and it can also be tripped by hand.

This turbine is also fitted with a Mitchell thrust block, and in addition there is a safety ball thrust, which only comes into play in case of the normal bearing seizing. The coupling between the turbine and generator is of the flexible type, the flexible half being on the turbine shaft. In order to keep the casing in alignment when lifting the top half off for repairs, pillars are provided which keep the casing from any lateral movement until clear of the blading. Similar pillars to these can be seen in the illustration of the large turbine unit.

The 12,500 K. W. Unit

The next unit that engages our attention is the 12 500 k. w. General Electric direct connected turbo generator, running at 1,800 revolutions per minute, and delivering 3-phase 60 cycle current at 2,200 volts to the station switchboard, from whence it can be delivered through step-up transformers to the sub-stations and also to the central station rotary converter. The exciter is built on to the shaft of the rotor.

The turbine is a Curtis type, nine stage horizontal high pressure, working at an initial pressure of 200 lbs. and 190 deg. superheat, and exhausting to a 29 inch with a 30 inch barometer. It is provided with forced lubrication on the bearings from a pump driven by gearing from the shaft of the rotor, and delivering oil at a pressure of about 35 lbs. per square inch to the bearings of turbine and generator. Governors for both ordinary speed regulation and emergency trip are provided. For keeping the temperature of the generator windings within limits a very complete ventilating arrangement is installed. The generator is completely enclosed, as is usual in this type of installation, and air is forced through the windings by means of a fan contained on the rotor shaft.



View showing exciter on the end of rotor shaft of 12,500 K.W. unit, and Webster feed heater above.

The air ducts are so arranged that air can either be taken from the engine room or from the outside, and in the basement under the generator a complete air washing and tempering installation is fitted. This ensures that air absolutely free from dust or grit is supplied to the machine, and also that it can be delivered free from moisture which might cause sweating on the generator frame or the windings.

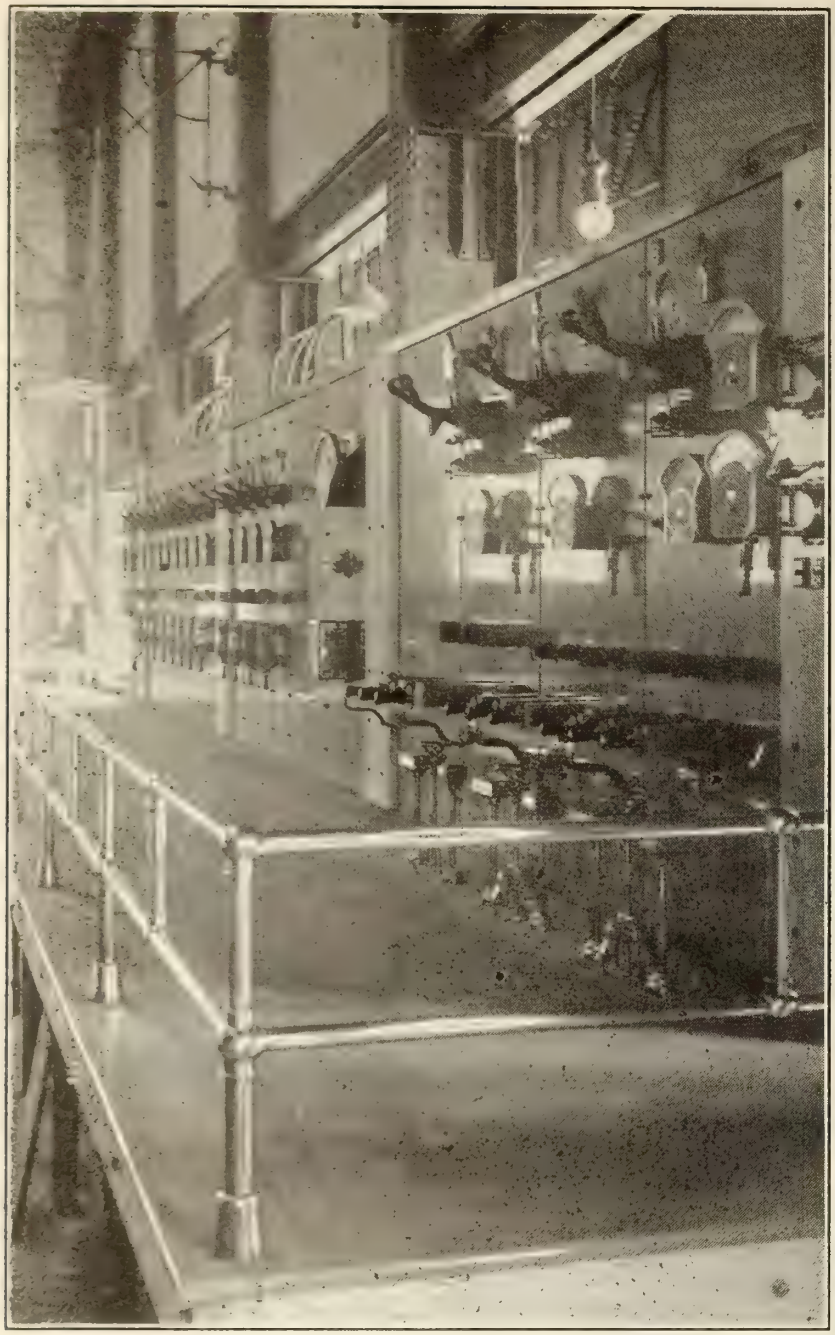
This unit is naturally the principal one in the station to-day, with its capability of such a large part of the total load. It is significant that the Montreal Street Railway are installing a second unit of the same size, which will be placed in the power house during the coming summer.

The condensing arrangements for so large a unit are naturally a source of interest, and rightly so. The exhaust steam from the last stage of the turbine passes to a condenser of the "Spiroflo" type, made by the Alberger Pump and Condenser Co., and fitted with Wheeler "Radojet" air pumps for maintaining the vacuum.

The circulating pump for this unit is an Alberger centrifugal pump driven by Terry turbines through reducing gears. The pump has a suction valve of 40 inches and a delivery of 36 inches. The delivery valve is controlled by a hydraulic cylinder, the suction sluice valves being worked by motor from the engine room.

The circulating pumps for the 2,000 k. w. unit and the barometric condensers have been arranged by the chief engineer in such a manner that any pump can discharge to any condenser, by an ingenious arrangement of by-passes. These necessitated a considerable amount of work in the way of pipe fitting, but the result achieved is excellent.

The condensate is of course used for boiler feeding, and here again we find the chief engineer has been using his initiative. For delivering the condensate



View of the switchboard, D.C. panels this end of gallery

to the heaters there were two Alberger volute pumps, single stage, arranged to works separately. Due to the somewhat high head they had to work at, there was some difficulty in handling the condensate, so Mr. Wright simply led the discharge of one pump to the suction of the other, and made a two stage arrangement of it, which got over the difficulty in great style.

These pumps then deliver to a Webster open heater, and from the heater there are two sources of supply to the boilers. One feed pump is a three-stage volute Alberger unit, driven by Terry turbine, while there is also an installation of two Weir compound vertical feed pumps, with a capacity of 18,000 lbs. per hour each. The heater and a portion of the pump can be seen in the illustration.

The Rotary Converter

There is a 2,000 k. w., three-phase 60-cycle Westinghouse rotary converter in the station, which can be operated either from the company's water power when that is available or from either of the turbo generators in the station. This converter with its motor-driven exciting unit, is situated in the east end of the station, close to the switchboard, and the transformer banks. The current coming from the water power is stepped down in the station to 2,200 volts, and the rotary converter takes alternating current at this voltage on the a. c. side, and delivers 600 volt direct current to the switchboard from the d. c. side, which is available for distribution to the trolley wires. There is also a small motor generator set on the engine room floor close to the rotary converter which is used to charge a set of Edison storage batteries, used in connection with the station signal lights.

The Switchboard

The main switchboard is situated on a gallery which extends for about half the length of the power house. At one end is situated the chief engineer's office, the rest of the gallery being entirely occupied with the panels.

At the west end are situated the three panels for the three reciprocating d. c. generator sets. Immediately next to these is the panel for controlling the rotary converter. Then come the feeder panels for the various 600 volt circuits, and at the far end the panel for the 12,500 k. w. unit. The panel for the 2,000 k. w. unit is situated on the engine room floor, and here also is the board for controlling the station lights and power circuits. Every panel is completely equipped with instruments and signal lights.

An interesting feature is the means of communication between the switchboard attendant and the assistant engineer on the floor on whom devolves the duties of starting up the d. c. units as they are required.

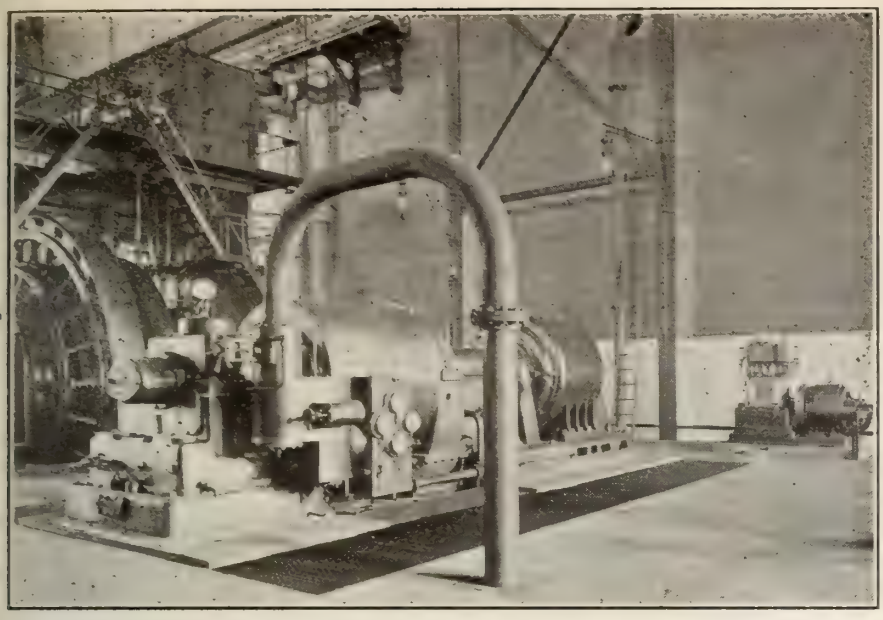
At each panel of the switchboard connected with the d. c. units is an instrument very similar to the telegraph used on board ship. It contains a dial on which are marked the words "stand by," "start," "full load," "slow," "finished."

There is a similar dial on the wall alongside each engine, and each order is illuminated with an electric light. When the switchboard attendant sees the load creeping up, he presses the stand by button and the light on the engine indicated immediately lights up and warns the attendant to get his engine ready. After a reasonable time the switchboard signals start, and the engine is started up and gradually brought up to speed. When the switchboad man has adjusted the load on his board he signals full speed and then the engine man knows his engine has got her load, and he can make his necessary adjustments. The same procedure is gone through as each engine is called into requisition, and when the load is dropping off, "standby" is signalled again, and the attendant gets ready to close down his engine as soon as the finished signal is flashed over to him. This system eliminates any confusion and running around, and saves either the switchboard man or the engine man leaving their particular duties for a moment.

Operating Features

To the operating engineer the details of operation are of as much interest as the details of the units used. The method of carrying on a plant of this kind is naturally somewhat different from that adopted in the smaller ones where one or two men perhaps carry on the whole job.

The plant is run in three shifts, and each shift has a complete operating crew, who have nothing to do with maintenance or repairs. There is a shift engineer in charge, and this man has to be a holder of a first-class certificate. This



The 2,000 K. W. Bellis & Morcom Turbo Alternator. The exciting unit can be seen against the wall.

engineer keeps a general supervision over the engine room, boiler room, and pump room, and is the executive officer for the rest of the crew. He has an assistant engineer, who looks after the starting and stopping of the various units in the engine room, and sees that they are running in good order as regards lubrication, etc. There are in addition three oilers, who find plenty to do with the various units. There are two switchboard attendants and two dynamo attendants, and this completes the operating crew in the engine room itself. Out in the boiler room there are two firemen and two helpers, which is a very small crew for the size of the plant, but this is made possible by the labor-saving arrangements in force.

There are in addition to the operating crew the repair men, but their number varies of course with the actual amount of work in hand. For instance, when a little job like lifting down a low pressure cylinder and boring it out is under way, there will be a little more help needed, than in the ordinary course of events.

The demands on the station as we have said are fluctuating, and therefore the various units have their times on and off. We may take a time in the slack hours of the morning, when probably the rotary converter will be carrying the small load on the line. The 12,500 k. w. unit will be running along light, ready to take up the burden at any moment. Soon the load begins to increase, little by little, and the large turbo generator is put in. The morning goes on and the workmen start out, calling for more cars, and more power. About five in the morning the smaller units are put in, one at a time and they carry on till probably eleven o'clock in the morning when the station is back again to the 12,500 unit and the rotary converter. This period of comparative quiet goes on until four o'clock in the afternoon, when the load starts creeping up, and the smaller units are again called into play, till about seven o'clock, when the demand slackens off.

It will be seen that there is but little idle time comparatively, and when the demand is on, everything has to be kept going. The units are at times operating under a considerable overload, and it is a not uncommon thing in street railway service, to get a sudden jolt that makes everything in the station jump for a moment. It is no place for a nervous man, that is a sure thing.

The Chief Engineer

Mr. Henry Wright, A. M. E. I. C., the chief engineer of the station, is well known to readers of Power House through letters from him and other contributions that have appeared in these columns. Mr. Wright learned his engineering in the British Navy, a very efficient school, and served in many parts of the world. He has been in the employ of the tramway company for a good many years, and has been prominently identified with educational work for the junior engineers through the Montreal branch of the C. A. S. E., of which lodge he is president. He is also Grand Vice-President of the organization, and is keenly interested in all work for the promoting of a higher standard among stationary engineers. He is himself of a very studious nature, and his home at Cote St. Paul contains a very complete little engineering reference library, of which he thinks quite a little.

Mr. Wright has a big job, which he carries on in a big way, exercising a keen supervision over the general operation of the plant, and training his staff to look efficiently after the details. He is an interesting man to talk to, and possesses a fund of information which is always on tap for those who are genuinely interested.

The writer feels that this article but inadequately covers the subject, but to enter into the subject in all the detail which he would like to, would occupy a whole issue of this magazine, which could hardly be allowed. If there are any points on which readers would like further details, the writer is sure that Mr. Wright, through Power House would be glad to supply them.

BOOK REVIEW

We have received from the D. Van Norstrand Co., 8 Warren Street, New York, a copy of "Operating Engineers' Catechism of Steam Engineering," by Michael H. Corston. The book, as its name would imply, consists of a series of questions and answers covering the whole range of steam engineering, from a practical standpoint. The subjects of heat and steam are dismissed with a brief eighteen questions, while the various types of boilers with illustrations of some of them occupy a series of 58 questions and answers. There are twenty-two chapters altogether, and the book makes a fairly comprehensive reference book for the beginner or the student of power plant engineering, or for the practical man who may be studying for the lower grade certificates. The author would have increased the usefulness of the book had he illustrated it more freely.

BULLETINS

The Mid West Engine Company, Andersen, Ind., have issued several bulletins descriptive of their various products, which include steam turbines, multi-stage centrifugal pumps, and single stage centrifugal pumps for deep well and other purposes.

* * * *

The United Conveyor Corporation, Chicago, have issued Bulletin No. 105 describing and illustrating the steam jet conveyor for ashes made by them. The various units comprising the conveyor are illustrated and several views of typical installations are given.

* * * *

The Murphy Iron Works, Detroit, have issued a bulletin describing their M. I. W. suspended arch, in which each brick is supported independently and can thus be removed or replaced without interfering with any other brick in the construction. The bulletin contains five pages, illustrated, showing the construction of the arch both in general and detail.

* * * *

The Combustion Engineering Company have issued a bulletin describing their type K stoker, which is recommended for boilers up to and including 200 H. P. The stoker is of the underfeed type, and is a modification of the type E stoker of the same company. The stoker can be regulated as to feed either automatically or by hand. The bulletin gives a detailed description with elevation and cross section of the arrangement, which makes it quite clear.

The Gasoline Engine In Municipal Plants

The Small Town Pumping Station Has Gone Through a Process of Evolution in the Last Few Years, and the Latest Practice Shows a Complete Change From the Old Steam Plant

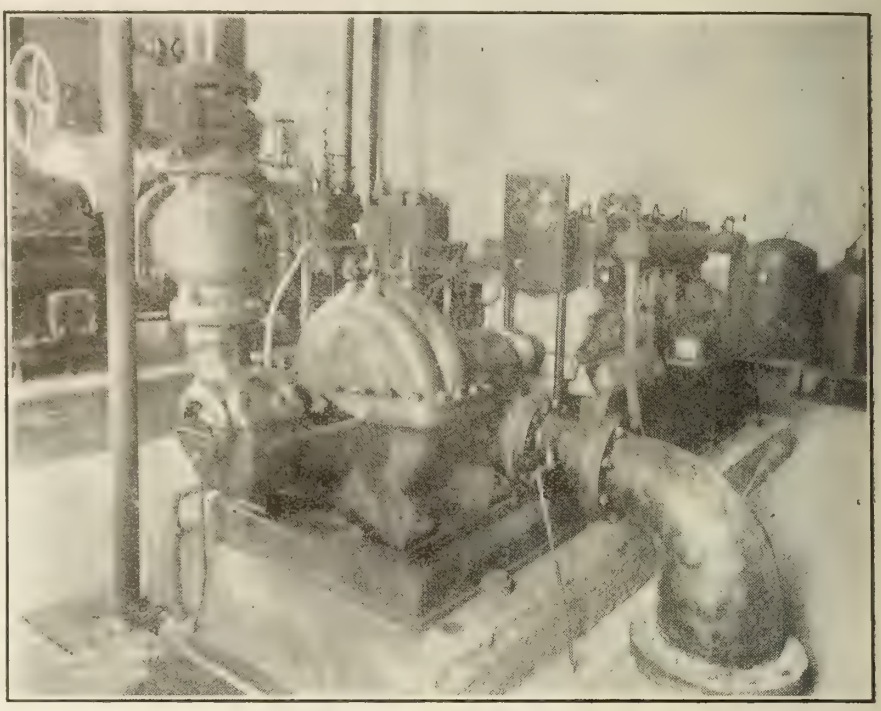
THERE has been of recent years an interesting development in the small municipality waterworks system. This has been in the nature of the standby equipment for the pumping station, which in past times, was invariably composed of a steam boiler and steam pump. In many cases this is being superseded in favor of the high speed gasoline engine, which can be direct connected to the main pumping unit in the station, through the medium of a clutch.

The pumping stations of these small towns have gone through a distinct process of evolution, from the days when the plant invariably consisted of duplex reciprocating pumps, connected to a high level storage tank, and supplied with steam from one or two horizontal return tubular boilers. With the introduction of hydro electric power, the main pumping unit became a centrifugal motor driven pump, and in order to provide for periods when there was no power available, such as occasions of electrical wire break downs or motor trouble, a steam plant was installed to take up the burden when necessary.

The straight steam station was quite an expensive proposition for the tax payers of the small town, for besides the high initial cost of the installation, the maintenance and labor cost was high. The efficiency of the plant was as a rule very low, partly on account of the class of labor which the municipal councils considered good enough to take care of their property, and partly because of the nature of the installations themselves.

In most cases, the actual pumping time of the station would be a very small portion of the twenty-four hours, under ordinary circumstances. The possibility of sudden emergency however, necessitated steam being kept handy on the boilers at all times, and the same possibility occasioned the presence of an engineer throughout the twenty-four hours. In some cases one man lived on the premises, and did the pumping, maintenance, and emergency work himself. In others, the work was divided into two shifts of twelve hours each. In either case, the expense in proportion to the actual pumping performed was high.

While some of these waterworks plants were kept in a condition highly creditable to the men in charge, it is unfortunately true that a very large number were allowed to sink into a state bordering on decrepitude. To this cause can be assigned a good many disastrous fires, which would have been easily checked had the pumping plant been able to perform its duty promptly and well. Sudden demands on a plant in which even the most ordinary necessities of overhauling have been neglected, will invariably produce disaster, and many little towns throughout Canada, have paid for this knowledge by seeing half of their property or in some cases all of it go up in smoke some fine day, when they were least expecting it.



Pembroke, Ont., Water Works.

The Motor Drive

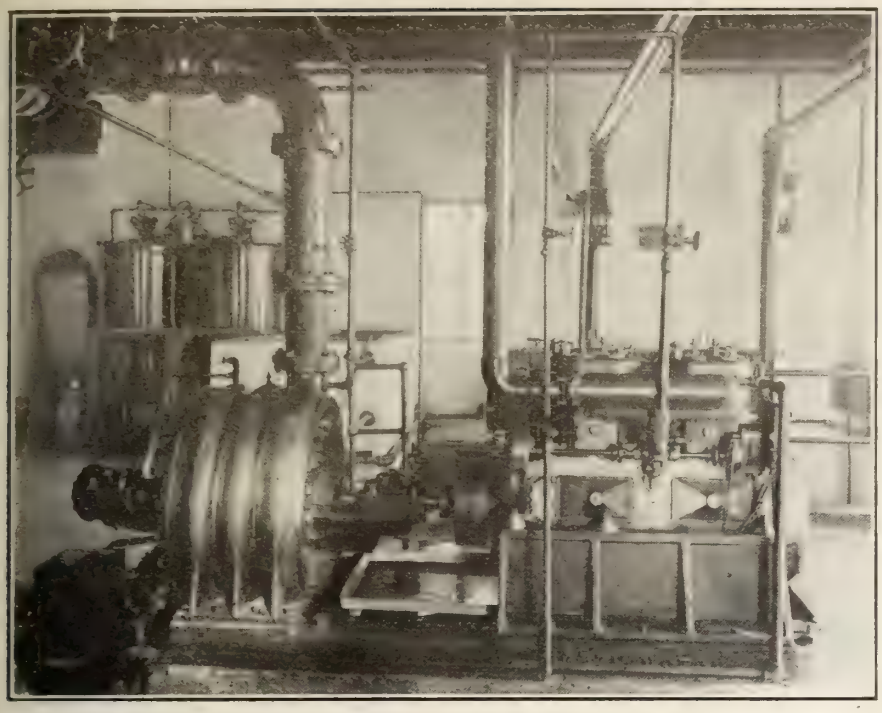
The gradual introduction of electric power at reasonable rates into all sections of the country, together with the development of the multi-stage centrifugal pump, capable of delivering water in large quantities and at high pressures, led to a great change in the small water works plant. The motor driven pump made a compact installation, and moreover one that was very simple of operation. The mere throwing in or out of a switch was all that was necessary to start or stop, and once started, it required practically no attention. However, as already stated, there were times when due to a variety of causes, no power was available, and as these times could not be foreseen, it was necessary to have a standby plant which was independent of the electric power.

The natural thing then was to install a steam pumping unit, usually consisting of one steam boiler, and a duplex pump of the type known as the Underwriter, and usually capable of delivering about 1,000 gallons per minute or enough to keep 3 streams going through 1⅛ inch nozzles. In order that this steam unit should be readily available, it had to be kept under banked fires, but in many cases, this was not done as a regular thing. Even under banked fires there would inevitably be some delay before the unit could be put into action. Where there was a reserve such as a high level storage tank this was not of such importance, but where the water was delivered direct to the mains, delay was of course dangerous. The ideal unit for emergency obviously was one that could be started at a moments notice, and be ready to pick up the load as soon as started. The logical outcome of this necessity was the recourse to the internal combustion engine, which possessed all the qualifications needed as far as reliability, ease of starting, and instant readiness for emergencies.

As the centrifugal pumps used in the water works are usually of high speed, and the usual heavy oil engine is of comparatively low speed, the use of Diesel engines would necessitate some form of reducing transmission between the pump and the engine. On the other hand the gasoline engine is essentially a high speed engine, and in addition, makers of gasoline engines have a much wider experience behind them than the heavy oil engine makers can claim, up to the present.

The Gasoline Engine Drive

The Sterling Engine Company of Buffalo, N. Y., having developed the gasoline engine for marine purposes to a high state of perfection, turned their attention to building a unit for municipal



Installation at Berthierville, P. Q.

water work and fire protection purposes, and have made many installations in Canada and the United States. We illustrate herewith a couple of typical installations in this country, together with a brief description of them.

The first illustration is of an installation at Berthierville, Quebec, and consists of a Sterling Model F 75 B. H. P. gasoline engine direct connected to a three stage turbine pump capable of pumping 900 U. S. gallons per minute. The pump was made at the Caledonia Iron Works, Montreal. The suction and discharge pipes are each 6 inches in diameter, and it delivers the water at a pressure of 125 lbs. per square inch. The engine is of the four cylinder type, and these engines are fitted usually with an electric self-starter. To make sure there will be no failure of the ignition system, there is a double ignition system installed. The plant at Berthierville was designed and installed by the New York Jewell Filtration Co., Montreal, and the engine was supplied by the Pyke Motor & Yacht Co., Montreal.

The second illustration shows the installation at Pembroke, Ontario. In this case the unit was installed to supersede the steam plant, the large steam pump being visible in the background. The engine and pump are in this case direct connected, the engine being a Sterling, and the pumps installed by the Turbine Equipment Co., Toronto.

These two illustrations show the general arrangement of these pumping plants and they are becoming quite prevalent among the smaller municipalities throughout Canada. The town of Dresden, Ont., has a typical installation of electric and gasoline driven pumps, the description of which was furnished us by the installers, Messrs. Lawrence & Lamb, of Dresden. There are two 4 inch single stage double suction centrifugal pumps, made by Fairbanks Morse, direct coupled to 25 H. P. induction motors. The pumps work at a capacity of 500 gallons per minute and a discharge head of 110 feet. They can be worked singly or in series, and for fire fighting purposes have a capacity of 110 lb. per square inch on four 1¼ inch nozzles. They can be started in less than a minute.

In case the hydro current fails there is a separate pump direct connected to a gasoline engine. This pump, is a Fairbanks 3 inch two-stage pumping 600 gallons per minute against a pressure of 90 lbs. per square inch. The engine is a Sterling F. C. 4 100 H. P. unit, equipped with an electric self starter, and double ignition, as is the usual practice with this type of engine.

These engines have some excellent performances to their credit in the way of long continued runs under heavy duty conditions, some instances of which we may give in a future article.

NEW SHAFT COUPLING

An ingenious method of coupling shafts for power transmission has recently been devised by the Coventry Chain Co. of Coventry, England. It comprises a double chain, i.e., two chains side by side, which passes round toothed flanges on shafts which it is desired to couple. The coupling is readily made by a bolt passing through adjacent links connecting up the two ends of the chain in the usual way. The coupling has a very high factor of safety, it is perfectly balanced, being machined all over, and does not require any lubrication.

The facility for disconnecting the shafts will be apparent, and the method gives a large number of possible adjustments by which one shaft may be angularly set relative to the other through the medium of the teeth into which the rollers of the chain are fitted. Although this coupling is not designed to replace universal joints it is obvious that a measure of flexibility is obtained, and it is stated that the coupling can be used to couple shafts with a deviation in angular movements of two degrees.

Relative end movement between the two shafts is also provided for, limited to about 1-16th of the shaft diameter. A special application of this chain coupling is with regard to automobiles, particularly in such cases as that of the magneto shaft where angular adjustment is sometimes required and where a slight flexibility is considered advantageous to avoid transmission of small vibrations. The coupling is manufactured in fifteen sizes which have been completely standardized, the largest type being capable of transmitting 180 h.p. at 100 revolutions per minute.

OFFSET SCREW DRIVER

Machine screws that have screw-driver slots in them often present a rather awkward problem when it is desired to screw in or remove them, owing to the location of the screws close to a wall or other projections. To overcome such conditions an offset screw-driver has been designed. Each screw-driver consists of a handle having a square forged end. On the four sides of this squared end are long narrow projections with which the slots of screw heads may be engaged. When using the screw-driver the handle is held at right angles to the axis of the screw. The projection that engages the screw-driver slot on any one side is at an angle of 45 degrees to the projection on each of its adjacent sides. Therefore if a screw is located in a cramped position, after turning the screw as far as space will permit, the screw-driver is given a quarter turn about its own handle axis by the fingers and is again applied. The screw-driver will put in or withdraw screws if only a one-eighth turn is possible. The design also has the added advantage that a considerable leverage can be applied to the screw if necessary. The manufacturers of the offset screw-driver are the Porter Products Corporation of Syracuse, N. Y.

BOOK REVIEW

The "Coal Manual" is the title of a book issued by the National Coal Mining News, Cincinnati, which deals with coal from all the aspects which are of use to a purchaser and user of this universal fuel. In addition to chapters on the analysis of coal, other chapters deal with the efficient burning of coal, and there are instructions to firemen and engineers. The book, which is published at $2.50 in the U. S., should be a valuable one for purchasing agents, plant managers, and engineers in general.

Heating Buildings By Reversed Heat Engine

The Process First Pointed Out by Lord Kelvin, as a Thermo Dynamic Proposal, is Here Fully Described and Illustrated. The Author Makes The Idea Very Clear

By F, B. MORLEY, D,Sc., M.I. Mech. E.

By Courtesy of "The Engineer."

LORD KELVIN, in 1852, pointed out that in heating a building by the burning of coal, while it might be thought at first sight that the ideal limit of efficiency would be attained if the whole of the heat of combustion were delivered to the air in the building, this was not the case. He went on to describe an indirect process employing a heat engine and a "warming machine" driven by the engine, by means of which the heat delivered to the building might be much greater than the heat of combustion of the coal consumed. So far as is known, his proposal has never been put into practice, but has remained an interesting thermo dpnamic speculation.

In these days of pressing need for conservation of fuel resources, attention has been re-directed to Lord Kelvin's idea, and in his James Forrest lecture on "Coal Conservation," in 1920, Sir Dugald Clerk stated that in his opinion, the practical difficulties which stood in the way of its application could be overcome. He again referred to the scheme in a recent lecture in Manchester, and mentioned that he understood that certain engineers were now engaged in developing it into a practical form. It may thus be of some interest to recapitulate and explain Lord Kelvin's proposal and to discuss its theoretical possibilities and the nature of the difficulties to be overcome in its application.

It being desired to pass into a building a supply of heated air, it is convenient that the air to be heated, be itself the working substance in a reversed heat engine or warming machine. The machine would have two cylinders, which Lord Kelvin called "ingress" and "egress" cylinders. We shall refer to them as "motor" and "compressor," since the air does work in the former while work is spent on compressing it in the latter. The cycle of operations would be as follows:—Air from the external atmosphere would be admitted into the motor cylinder for part of the stroke, the inlet valve would then close and for the remainder of the stroke the air would expand, falling in pressure. The drop in temperature during the expansion would be reduced as much as possible by making the motor cylinder of highly conducting material with a large surface for heat transmission. On the return stroke the air would be discharged into a receiver, also designed to encourage heat transmission and having its external surface exposed to the external atmosphere or, better still, to a stream of water. The intention, in fact, is to obtain as nearly as possible isothermal expansion and to obtain in the receiver air at a pressure below that of the atmosphere and as little below the outside air temperature as possible. The receiver might well take the form of a coil of pipes as shown diagrammatically in Fig. 1. As the object is to obtain warm air finally, the warmer the air is in the receiver the better, provided the receiver temperature is not obtained by the expenditure or electric motor.

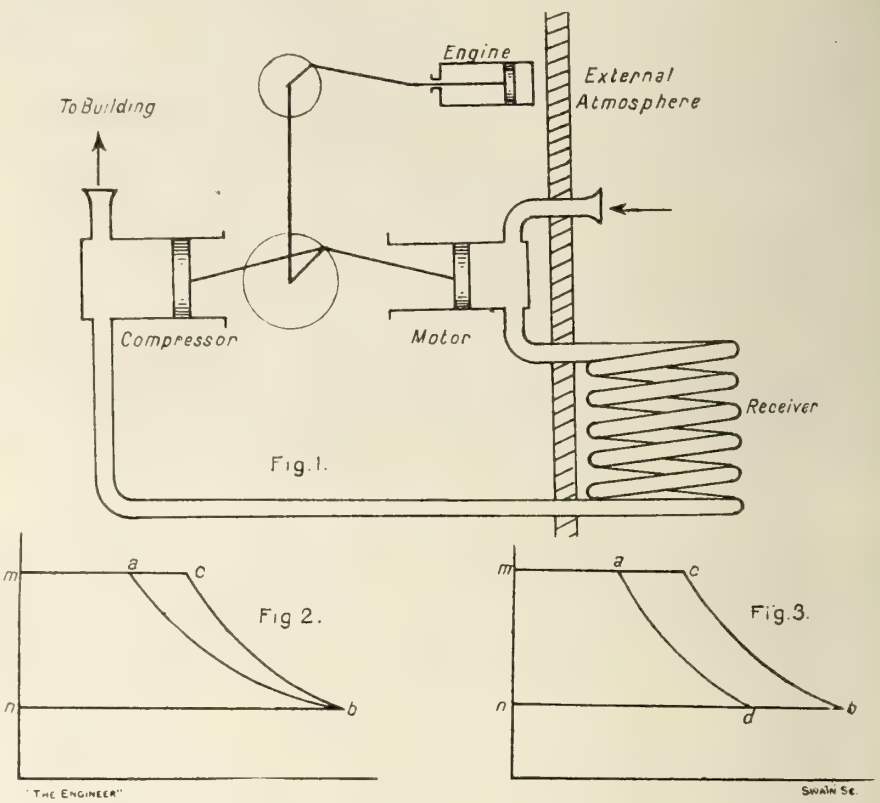


Diagram of Heat Cycle

The low-pressure air would then be passed into the compressor cylinder and would be delivered into the building. Fig. 1 shows diagrammatically the arrangement of the apparatus. The work spent on the air in the compressor would exceed the work done by it in the motor cylinder, the difference being supplied by an independent engine, water motor or electric motor.

The indicator diagrams for the process would be as shown in Fig. 2 or Fig. 3. In Fig. 2 it is assumed that the expansion is isothermal; the motor diagram is m a b n and that of the compressor n b c m. Fig. 3 is for the more likely case in which the expansion and is not isothermal, but in which the original temperature is regained in the receiver, the air therefore increasing in volume in the receiver from n d to n b. The point b n b c m is the same as before.

Lord Kelvin took as an example the heating of air from an external atmospheric temperature of 50 deg. Fah. to a final temperature of 80 deg. Fah. and calculated that by means of an ideal machine 1 lb. of air would be delivered per second with an expenditure of 0.283 horse-power for driving purposes. The heat equivalent of this power is 0.2 B. Th. U. per second. The heat required to warm 1 lb. of air from 50 deg. to 80 deg. Fah. is about 7 B.Th.U., so that the heat given to the air would be thirty-five times the heat equivalent of the work spent.

As a means of supplying the driving power, Lord Kelvin contemplated a steam engine capable of converting into work one-tenth of the heat generated by the combustion of coal, so that the effect of the whole combination would be that the heat imparted to the air would be 3.5 times the calorific value of the fuel. Modern steam plant of the best type has, of course, a much higher overall efficiency than one-tenth, amounting to 16 to 17 per cent. or even higher in especially good power stations, and internal combustion engines have a still higher efficiency. Thus after allowing

for losses of power and heat in the warming machine arising from friction and imperfect heat transference, it would appear probable that, by the method described, useful heating effect in the warming of air could actually be obtained with the expenditure of much less fuel than would be required to obtain the same effect by direct heating, even with the absolute elimination of all losses. Though at first sight this result is paradoxical, further consideration will show that it is in no way in conflict with the laws of thermodynamics nor, of course, therefore, with the law of the conservation of energy.

It has to be remembered that the heat given to the air is not all derived from the conversion into heat of the mechanical energy supplied. As a matter of fact, the bulk of the heat is taken from the atmosphere at the lower temperatures of the process. To quote Lord Kelvin with reference to the example already mentioned, "about 34/35 of the heat is drawn from surrounding objects and 1/35 is created by the action of the agent," i.e., by the conversion of the work spent in driving the machine. The function of the machine—the "agent"—is merely to bring about a temperature condition in which the working medium, viz., the air dealt with by the machine, is colder than the surrounding atmosphere or available circulating water, so that heat may thus flow from the surroundings into the working air. Then this heat, together with the much smaller heat equivalent of the driving work, passes into the building in the warm air delivered.

The process is exactly analogous to that in a refrigerating machine, having as essential elements (1) the cooling coils or cooling chamber in which heat H_1 passes into the working medium from the substance being chilled, this operation taking place at low temperature and pressure; (2) the cylinder in which the working medium is compressed to a higher pressure, work W being spent; and (3) the condenser in which the working substance at the upper end of its pressure and temperature range gives up heat H_2 to the atmosphere or to a water circulation. If W is measured in heat units, $W + H_1 = H_2$, and this is the only essential relationship between these quantities. Neither in theory nor in practice need H_1 be less than W, and, in fact, the ratio $H_1 \div W$ —termed the "coefficient of performance"—has frequently been found in tests of actual refrigerators to be as high as 9 or 10.

The idea that heat engine and a reversed heat engine working in combination may result in heat being delivered by the latter in much greater amount than that supplied to the former may be illustrated by the analogy of hydraulic machines, though the analogy is not perfect and does not constitute a proof of the relationship.

Consider a Pelton wheel supplied with a comparatively small quantity of water at very high head, and let the Pelton wheel drive a pump lifting water through a head of a few feet only. It is obvious that in spite of the inevitable losses the quantity of water pumped may be many times that supplied to the Pelton wheel since the ratio of heads is so great. The Pelton wheel is analogous to the heat engine supplied at high temperature and working with a large temperature drop; the pump corresponds to the reversed heat engine working with a small temperature range and discharging at moderate temperature. In the hydraulic case water falling from a high head is the means of raising a larger amount of water through a much smaller difference of head; so in the thermo-dynamic case, heat supplied at high temperature is the means of delivering a larger amount of heat at a low temperature.

Lord Kelvin also pointed out that the reversed heat engine could be used to cool buildings in hot weather as well as warm them in cold. In this case, referring to Fig. 1, the air flow is altered. The compressor takes in air from the building, compresses it and delivers it to the receiver, which now acts as a cooler. The operations in the compressor correspond to n b, b c, c m of Fig. 2 or Fig. 3, in which, however, n b is now at atmospheric pressure. The cooled high-pressure air is now admitted to the motor cylinder and expanded to atmospheric pressure again, the diagram being m a, a d. The temperature falls during expansion to a minimum at d and the cooled air is now delivered into the building again. This cycle has been used in practice in the Bell-Coleman type of refrigerating plant.

Returning now to Lord Kelvin's warming machine, it should be noted that the cycle he described is not a Carnot cycle, and that while in the example he gave, the heat imparted to the air entering the buliding was thirty-five times the work spent, part of this heat could not in practice be utilised in the building. The external air temperature being 50 deg. Fah., the minimum temperature in the building might be, say, 60 deg. Fah., so that of the 7 B. Th. U's. given to each pound of air in raising its temperature from 50 deg. to 80 deg., only that due to cooling to 60 deg. Fah.—i.e., 4. 7B.Th.U.—could be effective in the building, the remainder being carried away by the vitiated air. Of course, the attempt might be made to induce the air leaving the building at 60 deg. to heat the receiver to that temperature, but the impossibility of collecting all the air leaving the building as well as the difficulties of heat transmission at the low temperature differences involved would render this endeavor quite futile. In fact, it seems clear that a completely closed cycle of operations in the warming machine and the building is impracticable.

A variation of Lord Kelvin's proposal would be to take in air and compress it above atmospheric pressure, so also raising its temperature, and then circulate this warm compressed air through pipes in the building. After it had fallen to the minimum temperature permissible in these pipes, it would enter the motor cylinder, expand to atmospheric pressure and be discharged. The driving agent, as before, would have to supply the difference of the power of the compressor and the motor. If this method were adopted, however, air for ventilation would have to be separately supplied. It would seem advisable, on the whole, to combine heating and ventilation as Lord Kelvin proposed. The Kelvin method, it is to be noted, permits of the transfer of heat in the receiver being facilitated by the use of a water circulation, the heat passing from water to air rather than from air to air.

In attempting to estimate the practical possibilities of the scheme we are confronted with many points of great uncertainty. Some idea of the performance to be aimed at in the warming machine may be obtained by assuming that the heating effect of the whole plant is to be at least equal to the whole calorific value of the fuel burned. As regards the prime mover supplying power to the warming machine, it must be borne in mind that the work obtained is not the only useful effect, since, of the heat not converted into work, part may be employed for useful purposes. By the use of exhaust steam for heating purposes and also steam extracted at intermediate pressure, the total utilisation of heat in a steam plant arranged for combined power production and heating has reached in actual practice 48 per cent. of the calorific value of the coal consumed. With internal combustion engines, by the utilisation of the heat of the exhaust and of the jacket water a useful effect of over 50 per cent. has been recorded.

Speaking generally, we may assume that with a steam-driven warming machine we may obtain 15 per cent. of the fuel energy as work at the warming machine and 33 per cent. in direct heating, leaving at least 67 per cent. to be delivered as heat from the warming machine in order to bring the total heating effect up to 100 per cent. With the internal combustion type of prime mover the work may be 35 per cent. and the direct heating 15 per cent., leaving 85 per cent. as the duty of the warming machine. Thus in order to satisfy our assumption of 100 per cent. heating effect, the "performance ratio" —i.e., the heat delivered compared with the work spent—of the warming machine must be at least $67 \div 15 = 4.5$ in the former case and at least $85 \div 35 = 2.4$ in the latter. These figures, of course, might conceivably be much exceeded, and, on the other hand, even if the actual result fell far short of them, there might still be an advantage as compared with the method of heating by burning coal in open grates or even compared with using it in the furnaces of heating installations.

Calculations of the kind indicated above serve to show what the warming machine must be capable of in order to compete with other heating systems. The question as to what performance ratio we might expect from an actual warming machine is much more difficult to answer.

In the first place, it seems that the actual process would require to be pretty much on the lines of Lord Kelvin's proposal. The objections to the variation in which the air is first compressed above atmospheric pressure have already been stated. As regards the possibility of using a working medium other than air, it has to be remembered that by using air itself as the working medium ventilation as well as heating is obtained without any further expenditure either in power or plant. A reversed regenerative cycle similar to that used by Stirling in his air engine has been suggested. In the writer's opinion this cycle is not promising, since, as already pointed out, the cycle of operations required is not a closed one.

Whatever process be considered, the outstanding difficulty is the transference of heat between air on one side, at a comparatively small difference of temperature. In the absence of rapid transfer of heat the expansion in the motor cylinder does not approach the isothermal, and hence the work to be done by the driving agent is increased. Unless the air before it leaves the receiver can be brought to a temperature nearly equal to that of the external air or water supply, the heating effect of the whole process is reduced; yet to achieve this equalization of temperature or approximate to it would require either a large expenditure of power in forcing the air through small tortuous passages at high velocity or else the use of heating surfaces of very large extent. The success or failure of the method will evidently be governed largely by considerations of bulk and cost of plant as well as of mechanical and thermal efficiency.

The estimation of the prospects of success requires complete data regarding heat transmission at low temperatures, and it would appear that the first steps towards the practical development of the proposal must consist in investigations on heat transmission under the conditions indicated.

That the question of whether such a process is practicable may become one of great importance will be evident, when the dwindling fuel resources of the world are considered. Even though fuel as a source of power might be replaced by hydraulic and tidal power, the problem of keeping our houses and buildings warm in a fuelless world, to say nothing of obtaining the heat required for countless industrial processes, would still remain, and the only solution of it would appear to be the development of economical means of using power in order to raise temperature.

Power to borrow several million dollars to build a new city hall in Montreal, Quebec, may be granted by the legislature when the Montreal bill comes for final consideration before the legislative council. The old city hall which has been in use for the past thirty years was burned down early this month and the building was completely demolished. No time will be wasted in getting the new plans under way for the erection of a new city hall.

The Smoke Problem

By O. P. HOOD

Chief Mechanical Engineer, U. S. Bureau of Mines.

THE smoke problem means different things in different places. In the neighborhood of industrial plants, especially smelting plants, and cement plants, the term "smoke" is applied to material discharged, consisting of a mixture of solid particles (dust), fume which has condensed from vapors, and gases of various kinds that are produced in the operations. In the ordinary use of the word, however, "smoke" refers to the visible material which escapes from the burning of coal. White smoke usually owes its color to small drops of water which have condensed from the water vapor that is formed in the burning of coal. When smoke is black, the color is due to unconsumed particles of carbon and usually when the smoke problem is spoken of, it is this black smoke produced in the burning of coal that is referred to.

Many inquiries in regard to smoke are addressed to the Bureau of Mines, and the following brief summary has been prepared as covering the usual questions. For references to the smoke problem in England, I am indebted to a recent interesting paper on this topic by David Brownlie.

The smoke problem is nearly as old as civilization itself, for coal was being mined in Great Britain about the tenth century. In 1306, Edward I issued a proclamation prohibiting the burning of coal in the city of London, because of the "sulferous smoke and savour of the firing." In 1648, the people of London petitioned Parliament to prevent the importation of coal into the city. Beginning about 1750, when steam was applied to industrial purposes, coal began to be used more extensively, and consequently smoke became more abundant. In 1819, the Government appointed a House of Commons' committee to inquire into the matter, and another committee was appointed in 1843. Two reports were issued in 1843 and 1845. but no legislation was passed. Other investigations were made in 1846, 1854 and 1866, and finally, in 1875, the Public Health Act was passed, dealing with the question of smoke.

In the United States the problem, of course, did not develop so early, but as cities of considerable size developed here, the problem was also felt, and has been the subject of investigations, finally becoming of such importance that extensive investigations were made in Pittsburgh, Chicago and Salt Lake City. The Bureau of Smoke Regulation, in Pittsburgh, published a report in 1915, and the Chicago Association of Commerce published a large report in the same year. In the Chicago report, all the literature on the subject is reviewed, and a complete bibliography of references is given.

The black smoke which escapes when coal is burned, is due to incomplete combustion of the volatile matter of the coal. It is very difficult to produce black smoke in burning coals which are very low in volatile matter, such as anthracite. If the coal contains less than nine or ten per cent. volatile matter it is sure to be practically smokeless. It does not follow that the more volatile matter there is in coal, the more smoke is made in burning it, because the amount of smoke produced depends more on the way in which the coal is burned than it does upon the amount of volatile matter present. A coal with less volatile matter, if burned improperly, will make more smoke than a coal with more volatile matter which is properly burned. In fact, it may be said that it is possible to burn any coal without making black smoke, if proper means are adopted in its burning.

Mr. David Brownlie states, from English experience, that:

"One of the chief causes of black smoke is deficiency of draft, that is, there is not sufficient air passing through the fires to complete the combustion. Most boiler plants have cramped and badly designed flues, with chimneys too small, the usual practice being to erect a boiler plant on rule-of-thumb lines, with a chimney and main flue of scanty dimensions in the first place, and then to keep adding on extra boilers until the conditions as regards draft are hopeless. Most flues are also leaky and in a bad state of repair, which further cripples the draft. Much black smoke is, however, undoubtedly due to careless or ignorant methods of firing. If a large amount of raw coal is thrown on a fire, and then "lifted" immediately with a poker, nothing can prevent black smoke with ordinary coal. As a rule, firemen will fire one after the other the furnaces of a number of boilers, and the small amount of smoke produced by putting on the raw coal on each fire will combine to give black smoke at the chimney, just as they will persist in "lifting" all the fires almost simultaneously, causing still more black smoke. If a reasonable interval was left between the operation on each boiler, about 50 per cent. of the smoke would be prevented.

"The very earliest record we possess of any smoke-preventing device is that invented by a Frenchman named Delasme, which was exhibited at the Fair of St. Germain in 1685. This furnace is described by M. de la Hire in the 'Transactions of the French Academy of Science,' 1699, and also in Boerhave's 'Treatise on Chemistry.'

"The first reference in England to a black smoke device is that of James Watt's patent 1,485 (July 9, 1785), which was the last patent he ever took out. The patent is not very well expressed, but the general idea is to take the smoke after it has left the fire and burn it in another fire that has ceased to smoke, and so reduce the smoke by

at least half. It is not clear whether Watt understood the principles of combustion, i. e., the necessity of adding more air to prevent CO being formed, and he seems to have received more credit in the matter than is perhaps justified.

"In 1796 a man named Thompson, of whom practically nothing is known, invented definitely the coking arch of firebricks, and tried to prevent black smoke by admitting excess air on correct lines at one place only, the back of the bridge.

"In 1800 John and James Robertson, of Tradestown, in Glasgow, took out patent 2,437-1800, in which is explained in a most lucid manner the whole principle of 'coking,' whilst the same principle of coking, combined with extra heated air at the back of the bridge, was applied in 1820 by Josiah Parkes.

"Another method of endeavoring to prevent black smoke was to feed the coal regularly and in small quantities by mechanical means. The first practical mechanical stoker in the history of the world was invented by William Brunton at the Eagle Foundry in Birmingham, patent 4,387-1819, being a coking stoker with a horizontal revolving circular grate. The first sprinkling stoker, that is, one in which the coal is 'sprinkled' or thrown all over the fires was devised by John Stanley, 'a smith, in the parish of Manchester,' whose first patent was 4,692-1822. About 100 years ago, therefore, the scientific principles of combustion and the prevention of black smoke were understood and applied, and modern devices are merely developments of these original ideas."

Smokeless combustion requires the maintenance of a uniform and proper supply of fuel and air under conditions of suitable temperature, mixing and volume of combustion space. The one word "uniformity" embraces most of the ideals for smokeless combustion.

A bed of coals cannot find uniform conditions if the coal is fed in large lumps, so that powdered coal is the ideal limit for coal size. Intermittent handfiring cannot provide a uniform supply of fuel, since immediately after introducing coal into a fire a great quantity of volatile matter is distilled, calling for a large amount of air to burn it, while less air is required after the volatile matter has burned off. There is, therefore, a deficiency of air immediately after firing, and usually an excess for the remainder of the time. This cause of smoking is particularly bad when the draft is poor. Uniform, continuous mechanical feed of coal is, therefore, the ideal way to supply fuel. The intermittent firing of large amounts of coal, chilling the fire by its cold blanketing effect, and calling for heat for distilling gases, is not conducive to uniformity of temperature, so that continuous fuel feed is the ideal also from this consideration. Uniform mixing of air with the coal products is one of the most difficult things to attain. Irregular thickness of the fire, accumulations of ash and clinker in the grate, placing large amounts of coal on the fire at one time, opening of fire doors, leaky settings, all contribute to an irregular and variable supply of air when uniformity is desired, so that continuous mechanical operation aids again in approximating an ideal air supply. Uniformity in all of these things may be attained and yet a smoky fire produced, because in a small combustion space the gases may not have time to burn before they are chilled by cold boiler surface. Large combustion spaces are, therefore, necessary for smokeless combustion. With these ideals established every approach to them will tend to reduce smoke and give better combustion. The fireman that "fires little, fires often, fires quick" makes less smoke. Coal of approximately uniform size tends towards uniform fuel bed conditions.

At the present time, there are available for industrial plants a variety of designs of mechanical stoker that, when properly operated, produce smoke less combustion. But, they will, when improperly operated, produce smoke just as abundantly as improper handfiring will. In some parts of the United States, where the coal mostly in use is one that easily lends itself to the production of smoke, the smoke produced by household fires becomes a nuisance.

Salt Lake City is an illustration where the cumulative smoke of households, apartments, hotels, etc., tends to hang over the city, and is objected to for that reason. Smoke prevention in the household fire is a particularly difficult problem because the household fire is usually a small one, and the householder naturally gives it a minimum amount of attention which, of course, is conducive to the making of smoke. The simplest way to prevent the formation of smoke in household fires is to use fuel which cannot smoke even when no care is taken to prevent smoking. This means a fuel which has less than ten or twelve per cent. volatile matter in it. Anthracite coal which contains only three or four per cent. volatile matter, and coke, are admirable for this purpose. A great deal of study is being devoted, at the present time, to the carbonization of high volatile coals, for the purpose of producing a smokeless fuel. This is a mechanical and business problem, involving the use of suitable processes and equipment, so that by-products can be recovered and a low volatile coke product produced that will stand handling, and can be burned conveniently and economically.

BUREAU OF MINES REPORTS

In order to present to the public more promptly the results of its scientific investigations, the Bureau of Mines issues a series of brief mimeographed Reports of Investigations as an adjunct to the printed publications. Besides affording a medium of prompt publication of information, the Reports of Investigations provide a vehicle for the publication of briefer material which would hardly justify issuance in the form of printed bulletins. These reports deal with major metals, minor and rare metals, non-metallic minerals, petroleum, gasoline, coal, coke, safety, sanitation, mine accidents and other subjects. The reports are mailed free to interested applicants as long as the editions are available. Descriptive notices of issues in the series are mailed regularly to all who desire to receive the information. Serial 2316, just issued, is a subject list of Reports of Investigations issued to December 31, 1921, and describes some 300 repo whose range covers such subjects as abrasives, automobile exhaust gases, breathing apparatus, carbon black, Fuller's earth, liquid oxygen explosives, mine telephones, oil pipe lines, slate dust, valuation of oil properties, airplanes in mine-rescue work, powdered coal, helium, mine timbers, lead poisoning, smoke prevention, clays, building stones, safety in quarrying etc., etc. Serial 2316 may be obtained from the Bureau of Mines, Washington, D. C.

COAL STRIKE PROBABLE IN THE UNITED STATES

The following circular has been issued by the Canadian Manufacturers' Association:—

Wage agreements between the coal operators and employees in the United States expire at the end of the present month.

For some weeks there has been considerable speculation as to whether or not new wage agreements can be negotiated without a strike.

We have just received the following report from reliable sources in the United States, which is forwarded for your information:—

"Unless something unforeseen develops a suspension of operations in the bituminous coal fields of the United States will take place on April 1st. The anthracite coal situation depends on a meeting of the miners to take place in New York on the 15th instant. Industries in the United States are organizing in efforts to lay in stocks of coal before the strike may come."

Yours faithfully,
W. S. FISHER,
President.
J. E. WALSH,
General Manager.
J. T. STIRRETT,
General Secretary.

The Oakville town council has decidded on the installation of an auxiliary pump for emergency water works purposes. This will either be gasoline or steam driven.

Figures of the operation of the pulp and paper industry in Canada during 1920, just issued by the Dominion Bureau of Statistics, set forth in a striking manner the rapid growth of this branch of industrial effort during recent years. There are 100 pulp and paper mills all told; capital investment is given as $347,553,000.

Member of the Audit Bureau of Circulation

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

TORONTO, MARCH 20,

T. H. FENNER - - - - Editor
H. A. WILSON, - Resident Editor, Montreal
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Broadening Out

QUITE A LOT of conversation has been heard of late on the matter of broadening out, as applied to political parties, etc. It is a term that could aptly be applied to the stationary engineer, or as we would prefer to call him the power plant engineer. In these days the man who is able to take charge of any type of plant has to possess a knowledge which is of greater scope than was dreamed of by his not so remote predecessors.

In the case of the main driving units in the power house, or prime movers, there is a very wide variety. In this country to-day we have Diesel, semi-Diesel, gasoline, producer gas, and a few kerosene engines. We have all the divers types of Corliss valve engines, drop valve engines, high speed slide valve engines, and steam turbines. Of auxiliary apparatus there is no end, and it is continually being improved and new ideas put on the market. There is the refrigerating machinery of which again there are numerous designs, and two distinct types, the compression and absorption system. Again there are the plants which use steam for heating and motors driven from outside power to supply the power requirements.

There is no possibility of any man becoming acquainted intimately with every type of machinery and apparatus that goes into a power house. What he can do, however, is to master the underlying principles of the science of steam engineering and electrical engineering insofar as it enters into industrial power plant work, so that he can readily grasp the design and operating principle of any machinery which he may be called upon to handle. With such knowledge, built upon a firm foundation, he will never hesitate to tackle the biggest job which opportunity may put in his way. This is the method in which the power plant engineer should broaden out.

To the man who gives up the time and puts in the hard work necessary to acquiring the engineering education outlined above, there is the field of wider opportunity, which is always open to the well-informed man in any line of endeavor. He can achieve real professional status through the medium of the professional engineering societies which do not close their doors to the stationary engineer if he can prove himself capable of meeting their requirements. This again gives him the opportunity to meet and mingle with the best men in all branches of engineering, to hear the papers presented by them, and still better, to hear and perhaps participate in the discussion.

One side of the engineering profession which the average stationary engineer does not grasp thoroughly, and which is of great importance, is the commercial side. The particular branch which should interest him is the relation to the investment cost that the operating costs of the power plant bear, and how his plant would figure if he were selling power to customers instead of supplying it to the factory. After all, every power plant is engaged in the business of manufacturing and selling power, whether it is a public utility plant or a small factory plant with one boiler.

If every man who enters the boiler room as a beginner, went in with the intention of giving a certain number of years to the study as well as the practice of power plant engineering, and carried this intention out conscientiously, there would soon be a very marked difference in the status of the engineer in Canada. We fear, however, that the majority of men do not possess this spirit, but rather, are just willing to learn enough to get by with.

The attendance at the classes in the technical schools, which, like salvation, are free, does not show any wild demand on the part of the younger men for education. Of course, it may be that they are already advanced beyond the stage that the technical school classes cover, and therefore do not feel like wasting time. We would suggest to them, if there are such men in the boiler and engine rooms of the city and country, that there are still the universities, so that they need not stand still.

Heating By Electricity

A UTILIZATION of electric power, otherwise idle for certain periods, for the generation of heat is well known in Europe, where it has been used for some years. It is now coming into use in Canada and the United States. The generation of heat by electricity used for no other purpose is not an economical proposition, but when electricity is purchased at a flat rate, and would otherwise be idle for considerable periods, it becomes quite feasible. The general method adopted, is to turn the current when not in use for power purposes, through resistances which are arranged to dissipate their heat by radiation to the water in a boiler, or in other cases, making the water itself the resistance.

In heating water and converting it into steam in this manner, there is very much less loss by radiation than is the case when coal is burned in a furnace, and the losses incident to the chimney draught and inefficiency of combustion are of course eliminated. In the case of the boiler with the water acting as the resistance, the heat transfer is direct, and there are no losses.

It would seem that there is a possibility of using this method of steam generation with a system of storage. The use of steam accumulators has been developed in connection with pulp and paper mills particularly in recent times. There might be more heat available from electric power at some particular time than could be utilized at the moment. In such a case, if means were provided to store that heat in the form of steam until the demand was sufficient, we should have an ideal system.

Ideal systems unfortunately are not always practicable, and there is the question of the cost of providing storage capacity with sufficiently good insulation to make it of use. This cost might easily be more than the saving to be obtained, but the conditions at any one plant might make it feasible while at a second one it would be out of the question.

The Operators' Point of View

CLINKERLESS FIRE

By H. Gradt

In writing on this subject it will mostly interest firemen, also engineers who are doing their own firing, in a hand fired furnace.

The fire in this article will be slack coal, but if anyone is fortunate enough to be using better than slack, why this problem will be easier worked out, as the method applies to both kinds of fire. Efficient firemen do not receive the credit they deserve, as a rule, and I maintain the word "job" should be eliminated and the word "profession" substituted, to all those that are worthy and can show results.

My income since I started engineering first in Canada has been raised 157½ per cent. largely due to possessing the knowledge of burning slack. I had to make a few moves of course but each employer realized the importance of the fuel question, so if I see fit to make a few more moves I will be drawing a fair salary.

In starting my fire I never clean out all the ashes, leave about 3 inches on the grates then take a poker made of ¾ iron with a 3½ in. hook bent at right angle on one end and pull this poker back and forth on the grates with the draft on, until the coarse cinders are free from fine ashes. The fine cinders drop through the grates and the fine ashes escape through the stack. Next level the remaining cinders evenly on the grate, and pack them down evenly, which is all done with the same poker.

With a little practice this can be accomplished in a very short time. The gain is worth the trouble.

Some readers may wonder right here what is the idea of the cinder bed on the grates?

Three good reasons, viz.;—

1st.—Prevents live coal and fine fuel from falling in the ash pit.

2nd.—A fire will burn 40 per cent. better on a cinder bed than from the bare grates due to the fact that the air is more uniformly distributed.

3rd.—Should a clinker be formed it is much easier to remove it from the cinder than it would be to pry it loose from the grates.

Having the cinder bed completed, next sprinkle on some live coals, preferably with a shovel, evenly, taking care that the coals are not closer than 1½ to 2 inches. Then put on about 2 inches of slack, using a little more draft in starting a fresh fire than usual, and fire light for an hour or so, always placing the coal where the cinders start to show up. Never put green coal on a white heat fire bed, as this is the secret to avoid clinkers. After firing for about an hour you will notice the fire will burn better and quicker and then the drafts can be checked so as to maintain the desired steam pressure and the furnace can be fired heavier, say about 4 inches.

If the coal is coarse, say like the size of goose eggs, a much heavier fire will give better results. The idea is to stop excess air going through the fuel bed.

If a bluish color appears in different places in the newly fueled bed, this is an indication that there is no air passing through those certain spots and some obstruction is the cause, either fine ashes in the cinder bed, or the grates may be plugged up.

If it happens to be fine coal dust just fire around those spots and very likely next fire those spots will have disappeared.

If a dull red spot appears in a fire bed you may be sure there is the old familiar clinker under those dull coals.

If it is a new fire and not badly clinkered, by firing around those spots they may burn out in one or two fires, if not, my remedy would be to break up those clinkers so that the air will pass through them.

My definition of how a clinker is made, is by adding more fuel to a fire before it is properly burned down, thereby obstructing the air from passing through the burning coal causing it to run and glaze.

Have run a fire 15 hours on slack without cleaning the fire using only one 16 x 66 H. R. T. boiler and pulled a mill of 200 bbl. capacity and elevator attached without having any clinkers in my fire.

Particular attention is given to a new fire and when it has been burning for an hour or so and is burning clear, after that I never use a slash bar or poker as this disturbs the ash bed and destroys the porous form which the ash bed naturally forms by proper firing.

Considerable advantage is obtained by letting the coal slide from a shovel so it will fall instead of slide on the fuel bed as sliding green coal also, especially on a new fire, moves the cinders to some extent and partly closes the porous portions.

I use force draft and think it has an advantage over natural draft, as the stack draft can be checked just enough to allow the smoke and gas to escape thereby reducing the stack temperature.

The force draft can be adjusted to meet the requirements of steam consumed. The intake of the force draft in this plant is located near the ceiling of the engine room and supplies the furnace with warm air, which also is an advantage over natural draft.

Am of the opinion that anyone wishing to bring my theory in to practice will not succeed the first time completely, but practice makes perfect, and anyone wishing more information on this subject may get it through Power House or the writer direct.

NOTES ON STEEL PIPE

By James E. Noble

Sometimes the statement is made that steel pipe is greatly inferior, in lasting qualities, in comparison with wrought iron. This statement may be made by persons who have made little, if any effort to inform themselves from reliable sources as to the truth or falsity of their opinion. The truth of the matter, or what at least looks like the truth, secured after exhaustive tests of long duration, and easily available to anyone interested would seem to prove that a high grade steel pipe, of modern manufacture, is quite as good as the old reliable wrought iron. For some purposes it might even be better than the latter, and some surprising facts will often show up even in ordinary experience.

About five years ago I had a hurry call, to run to some heating coils, a steam line carrying 100 pounds pressure, the line being several hundred feet long. There was no steam pipe on hand but there was a quantity of black, compound coated 1¼ inch steel, electric conduit. I was advised not to use this pipe by men who predicted all kinds of trouble if I did so, and I was told that it would become pitted and leaking over its entire length in a short time, and that the compound would cause continued trouble by lodging under valve seats, etc. However I was used to following my own opinion until shown that I was mistaken, so, taking a chance I installed the conduit. This pipe, after five years service, is still steam tight and apparently good for a long time yet, there has been no valve trouble from the compound coating. Under certain conditions one danger there could be from using such coated pipe, that is the danger of some of the detached coating reaching the steam boilers, in the case in

question the conditions were such that this was almost impossible. In an emergency some years ago I used a considerable quantity of ½ inch and ¾ inch galvanized steel electric wire conduit for a hot and cold water supply carrying 40 pounds pressure.

This pipe is still in use and is still water tight while some ordinary galvanized iron water pipe which was installed about one year after the conduit, and which was operated under the same conditions, developed so many defects that it had to be replaced with new pipe.

OFFERS A SUGGESTION

In response to the notice to the effect that our columns would be open to suggestions from readers as to how to obtain action on the Dominion wide certificate, we have received the following letter from a correspondent:

The Editor,

Power House:

With reference to your notice in March 5th, "Power House," in regards to the "Dominion Wide Certificate," and by way of suggestion am offering the following:—Why not print a resolution as set forth below, or one of similar nature, in the "Power House," and let every engineer cut it out of his paper and mail it to you, and you in turn forward it to the proper parties who would act. Should there be any engineers who do not take the "Power House," (which I hope there are not) let him copy the resolution from his brother engineers' paper, sign and send it in. I would also advise him to send in $2 for a year's subscription to our national engineer's magazine as he does not know what he is missing if he does not take it.

The resolution I propose is as follows:

Resolved, that the stationary engineers of the Dominion of Canada, deem it in the best interests of the profession, that the certificates of competency issued to engineers, should be issued on the authority of the Dominion Government, instead of the Provincial Governments of the various provinces. That engineers at present holding provincial certificates be granted a Dominion certificate of the same grade. That we the engineers of Canada request the Grand Lodge of the Canadian Association of Stationary Engineers as the representatives of the stationary engineers of the country, to take up the question with the Governments involved.

We pledge ourselves individually and collectively to heartily support the movement financially or otherwise.

This is offered as a suggestion to start the ball rolling, and get some action.—C. T. M.

STEAM FLOW METER

Question:—Please describe a flow meter, and tell me all the data that can be secured from a steam flow meter chart.—F. H.

Answer:—There are several types of steam flow meter, which all, however, operate on the same general principles. A pitot tube, or throat orifice on the same principle as a Venturi throat, is placed in the steam pipe and the difference of pressure on the two sides of the tube are communicated to two chambers containing mercury, the difference of pressure in the two chambers causing a rise and fall of level similar to the action of the water in a U tube such as used on draught gauges. The recording mechanism is attached to floats on the surface of the mercury, and the dial of the instrument is calibrated to read in lbs. of steam per hour, or thousands of pounds per hour.

A little more detailed explanation of one or two of the principal makes may be useful. In the meter made by the Republic Flow Meter Co., the pitot tube communicates with two openings leading into individual reservoirs. The openings in the pitot tube are so placed that one faces the flow of the steam in the steam pipe, while the other opening faces the opposite direction or perhaps it may be plainer if we say one faces up stream and the other down stream, considering the flow of steam in the pipe as the stream. The steam which enters the opening facing up stream causes in addition to its static pressure, a further pressure caused by its velocity, while the pressure on the tube facing down stream is due only to the static head. The up stream tube is called the dynamic tube and the down stream the static tube. The result of the extra pressure due to velocity in the chamber in communication with the dynamic tube, is to depress the mercury, and this results in raising the level of the mercury in the static chamber, the two being connected by a U tube.

The meter body, recording instruments, and ground are included in a circuit current being supplied by a small transformer. The circuit is completed by means of contract rods which are supported in the static chamber, these rods being of different lengths. The terminal post on the meter body is connected to a series of resistances, and as the mercury rises successively touching the rods, the resistances are gradually cut out and more current allowed to flow through the meter, which increases the reading on the instrument board. This instrument is calibrated to read in units of flow.

The Bailey Flow Meter instead of using a pitot tube, uses a metal plate containing a carefully calibrated orifice, which is inserted between a pair of flanges. The differential pressure on the two sides of the orifice is conducted to the inside and outside of a bell shaped vessel floating in a chamber of mercury. The increased pressure due to velocity is allowed to act on the inside of the bell, causing it to rise, and the movement is transmitted through a lever direct to the recording dial.

The General Electric Co. make a flow meter which operates with a pitot tube the difference of pressure being transmitted to the two legs of a U tube. The recording in this instrument is achieved by means of a magnet operated from on top of the mercury column, which in turn operates a magnet on the face on the dial.

It will be understood that there are various features about all these instruments that cannot be alluded to in a general answer of this kind, and we would advise our reader if he is interested in the matter to request detailed description from the various makers.

EVAPORATION QUESTION

Question.—How much heat would be required to convert 9 lbs. water at 140 degrees into steam at 140 lbs. per sq. in. absolute, the steam being 2 per cent. wet? What is the equivalent evaporation under these conditions? If one pound of coal with a heat value of 14,500 B. t. u. evaporates this amount of water under the conditions named, what is the efficiency of the boiler?

Answer:—The total heat of the liquid at 140 lbs. per sq. in. absolute is 324 B. t. u. The latent heat for saturated steam at that pressure is 865.5, and for steam of 2 per cent. moisture will be 865.5 x .98.

The total heat will then be S plus L 324 plus 865.5 x .98.

Feed water at 100 degrees is 68 above 32 F., so that the total heat required for the conversion will be

324 plus 865.5 x .98 minus 68, equals 1,004.19 B. t. u. per lb.

1,004.19 x 9 equals 9,037.71 B. t. u.

The latent heat of evaporation from and at 212 degrees is 965.8 so that the equivalent evaporation will be as

965.8: 1,004.19 so is 1: x

which gives 1.03 as the equivalent evaporation.

The efficiency will be the total heat of evaporation of nine pounds of water from 100 degrees to steam at 140 lbs. absolute and .98 degrees dry, divided by the total heat value of one lb. coal and multiplied by 100.

$$\frac{9{,}037.71 \times 100}{14{,}500} = 62.32 \text{ per cent.}$$

A CORRECTION

In the March 5th issue of Power House, page 37, column 2, the formula for the area of the segment of a circle was, due to a typographical error, printed in a form which made it read quite wrong. The formula is as follows:

$$\frac{4 \times h \times h}{3} \times \sqrt{\left(\frac{d}{h} - .608\right)}$$

MONTREAL LODGE C. A. S. E.

Montreal Lodge, C. A. S. E. held their regular meeting on March 10th, Mr. Fenner, Editor of "Power House," was a visiting member from Toronto on this occasion, and enjoyed the opportunity of meeting many of his old friends.

By GEORGE R. ARCHDEACON, A.M.I.E.E.

AS ALREADY mentioned in the last chapter when we have a number of resistances in parallel, the total resistance of the circuit is reduced and the method of determining the total resistance is more complicated than when the resistances are in series.

Fig 1 illustrates 3 separate resistances in parallel, each resistance being a different value, as indicated by the figures against each resistance.

The following rule must now be learned:—

The combined or joint resistance of two or more resistances when connected in parallel is equal to the reciprocal of the sum of their respective conductances.

The reciprocal of a number is the inverse of that number and is obtained by dividing that number into unity.

Example:—

$$\text{The reciprocal of } 5 = \frac{1}{5} = .20$$

$$\text{The reciprocal of } 7 = \frac{1}{7} = .142$$

$$\text{The reciprocal of } 20 = \frac{1}{20} = .050$$

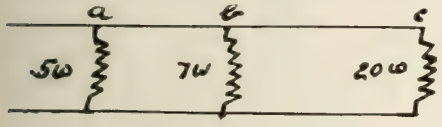


FIG. I

Substituting the resistances shown in Fig. 1 the total resistance will be as follows:—

$$\text{Total R} = \frac{1}{\frac{1}{5}+\frac{1}{7}+\frac{1}{20}}$$

Reciprocal of sum of conductances

Sum of Conductances

By adding the conductances together we obtain the combined conductance. If we now take the reciprocal of the combined conductances we have the total resistance.

Remembering that the conductance is the reciprocal of the resistance, we must add all the conductances together:—

$$\frac{1}{5}+\frac{1}{7}+\frac{1}{20} = .20 + .142 + .050 = .392 \text{ mho.}$$

As the resistance is the reciprocal of the conductance, we must now take the reciprocal of the total conductances.

$$\text{The total resistance} = \frac{1}{.392} = 2.55 \text{ ohms.}$$

Current in a Series Circuit

In any electrical circuit there is always resistance, and to overcome that resistance and cause current to flow it is necessary to have a voltage behind the current to "push" it through the circuit.

In other words, to "push" amperage through ohmage, it is necessary to have voltage. We cannot have a circuit without resistance, and we cannot force a current through resistance without electrical pressure.

The pressure necessary to send current through resistance is expressed by Ohm's Law:—

Volts = Ohm's × Amperes.

The current flowing round a series circuit will be the same value at all parts of that particular circuit.

It will be quite obvious if a circuit consists of a wire of uniform material and size, the current flowing through that wire, will be the same at all points along the wire.

Generally a circuit is not of uniform material or resistance, this often causes the student some confusion of thought as to how the current can be of the same value in all parts of such an uneven circuit. It is therefore worth our while to pause to consider this problem in a more detailed manner, and make it quite clear for all time.

Current is the rate of flow of electricity in amperes, or in coulombs per second.

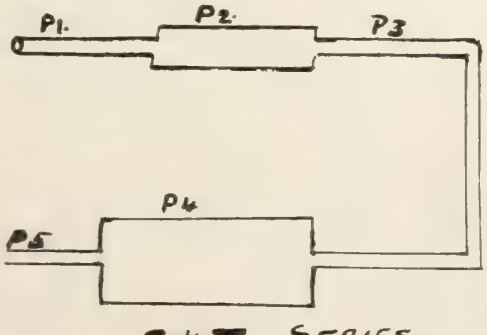


FIG. II SERIES

A "coulomb" is a definite quantity of that invisible "something" which we call electricity, (just as a pint is a definite quantity of water) and is considered to be one ampere per second.

In Fig. 2 there is represented a number of pipes connected together "in series" each of these pipes are of different diameter, and connected to a water supply, so that it flows through the whole system of piping.

The rate of flow could be expressed as so many pints or gallons per second; and it will be obvious that this rate of flow must be the same all round the system. If the rate of flow at any point in the smallest pipe is 2 pints per second, it must be exactly the same at any other point, say in pipe 2 or 3.

The reason for this being that more water could not pass by here than there is room for ahead, as water is incompressible. Therefore the rate of entry of water at the big pipe must be exactly the same as the rate of flow from the smallest pipe.

Electricity being incompressible, the above analogy will apply.

Whenever resistances are connected in parallel, the total resistance of the circuit is reduced.

This again at first glance seems rather strange, that the adding of more resistance to a circuit, results in a reduction of the total resistance of that circuit.

Let us therefore again make a water analogy. Consider each additional resistance as being an additional circuit, forming an additional pathway through which the current will flow.

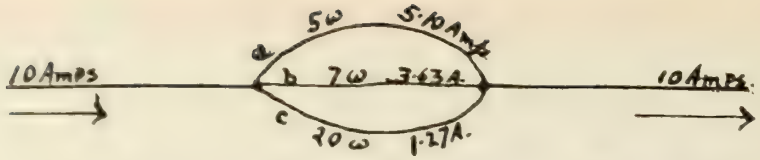
In Fig. 3 we have another system of pipes, from which it is readily seen, that the more pipes added to the system, connecting the top to the bottom of the system, the greater the rate of flow will be, from the top to the bottom, because the resistance to the flow is reduced by each additional pipe added to the system.

It will now be quite obvious that in dividing up a circuit into a number of branches, the current will vary in each branch, and such variation in current flow, will be entirely controlled by the resistance of each particular branch.

In Fig. 4 the main current is taken as 10 amps. Let us use the same resistances as calculated in Fig. 1 viz., 5 ohms, 7 ohms, 20 ohms, respectively.

To find division of main current in the branches of a circuit, when the strength of main current is given, also the resistance of the branches.

Suppose in Fig. 4 the resistance of a, b, and c, were 5, 7, 20, ohms respectively, and the main current was 10 amps.



DIVISION of CURRENT THROUGH PARALLEL CIRCUITS.
FIG IV

How much current would go through each branch?

The rule regarding the division of current in such cases may be stated as follows:—

When a continuous current divides to flow through two or more parallel branches in a circuit, the fraction of the total current in each branch will be directly proportional to its relative conductance.

1st Step.—The resistance of each branch is 5 ohms, 7 ohms, 20 ohms respectively.

The conductance of each branch will therefore be:—

$$\frac{1}{5} = .200$$

$$\frac{1}{7} = .142$$

$$\frac{1}{20} = .050$$

and the total will be .392 mho.

2nd Step.—It may therefore be assumed that the total conductance of .392 mho is made up of 392 small units, and that 200 of these are in a, 142 in b, and 050 in c. It may also be assumed that the current splits up into 392 parts, of which 200 flows through a, 142 flows through b, and 050 through c.

The values of the currents through the three branches will then be:—

Through a, $\frac{200}{392}$ of 10 amps = 5.10 amps.

Through b, $\frac{142}{392}$ of 10 amps = 3.63 amps.

Through c, $\frac{050}{392}$ of 10 amps = 1.27 amps.

Total 10.00 amps.

Branch circuits, or parallel circuits, sometimes develop accidentally. Sometimes when a switch is turned on, the lamp fails to light, and a fuse is "blown." Upon investigation a "short circuit" is discovered. This is only another way of saying, a parallel circuit of considerably lower resistance has been established. Like most human beings, electricity always chooses the "line of least resistance," consequently whenever the parallel circuit is established, the current will rush down that avenue, if its resistance is lower than that of the main circuit.

In using an ammeter to obtain high current readings of over 10 amps, a device is used, which only allows a very small fraction of the total current to flow through the ammeter, the balance is sent round in another branch circuit. When so applied this is called a shunt, but strictly speaking it is nothing more or less than a "short circuit" whose resistance has been carefully calculated to prevent too great amount of current flowing through the circuit, resulting in possible damage to the instrument, operator, or fuses.

Frequently in the operating of the power plant it is of great importance that the current consumed by various motors, heaters, etc., should be actually measured to learn if they are operating efficiently. Upon such occasions it is necessary to connect the motor or heater, which is to be tested with an ammeter in series with the mains supplying the current. It is then most important that the correct shunt be chosen, otherwise when the current is switched on, the instrument will be burned out, and rendered quite useless.

Therefore never on any account use a shunt which has not been made for the particular instrument you are using, because the resistance of the unknown shunt will permit more or less current to pass into the instrument, resulting in errors in the reading, or even lead to the actual burning up of your instrument.

In conveying steam or water through pipes, a certain size of pipe will only suffice for a certain quantity of steam or water. Similar conditions prevail in conveying electricity along wires, only a certain quantity of current can be conveyed by a certain size of wire, if these limits be exceeded the wire will melt and the circuit be broken, and perhaps a disastrous fire result. Care must always be taken to see that the correct size of wire is chosen, and when once installed never overloaded. The carrying capacity of a wire is limited by a fixed quantity, as established by the various power companies and insurance companies. These limits are expressed as the current density of the conductor.

The current density of a conductor is expressed in amperes per sq. in.:

This may easily be found as follows:—

Let D stand for Density.

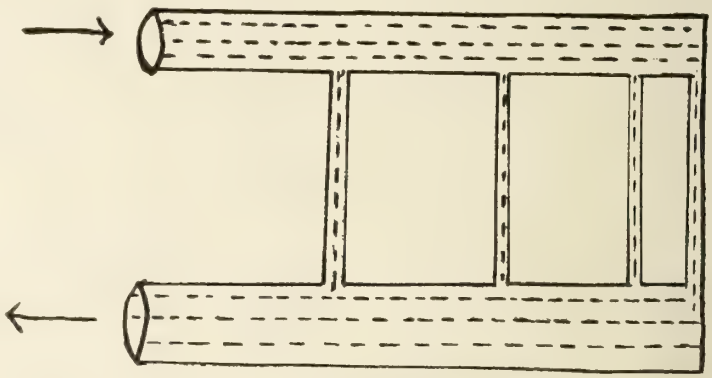


FIG III PARALLEL.

Let I stand for Current in Conductor.

Let a stand for Sectional Area of Conductor.

Then $D = \frac{I}{a}$; $I = a \times D$; $a = \frac{I}{D}$

A very conservative loading for all wires and cables is 1,000 amps per sq. in. It makes all calculations simple, and provides a fairly reasonable voltage drop.

It has already been mentioned that excessive amount of current will cause the wire to melt. It is therefore apparent that when a current of electricity traverses a wire, heat is generated.

When the heat is generated, energy is dissipated, volts are lost, and work is said to be done.

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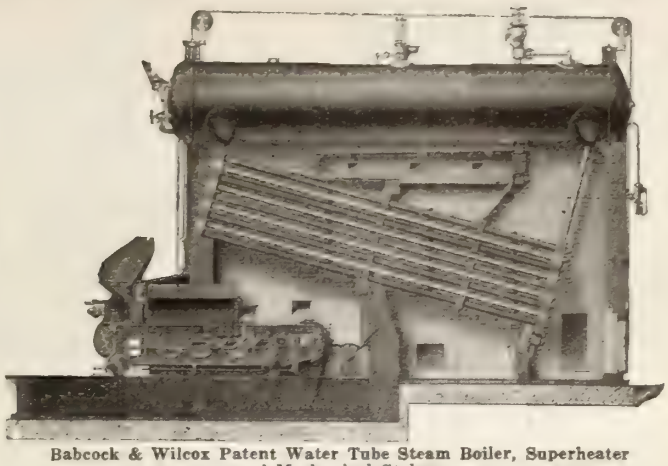

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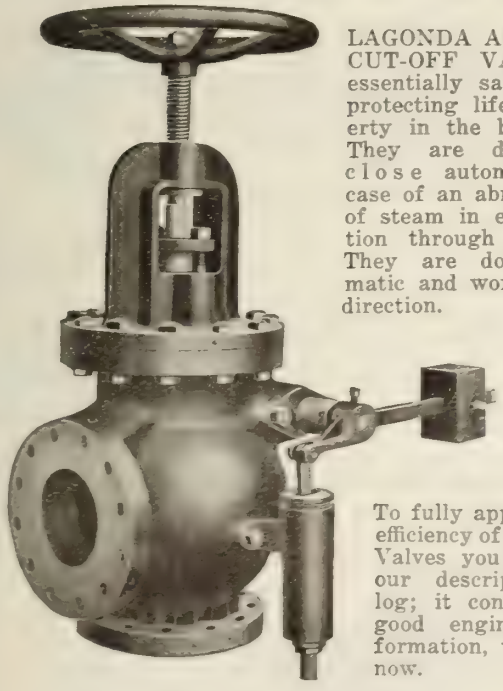

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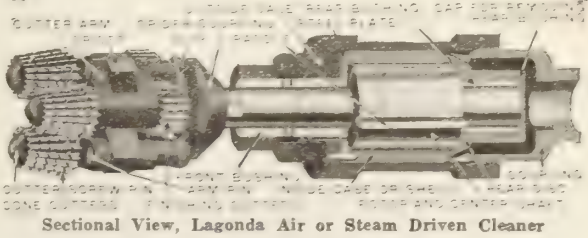

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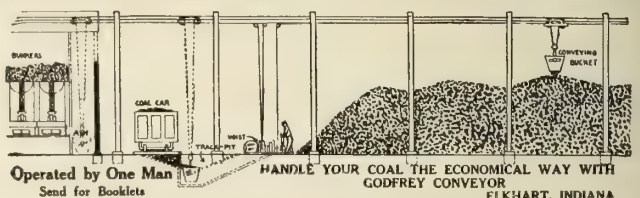

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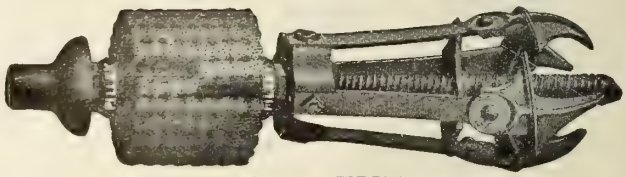

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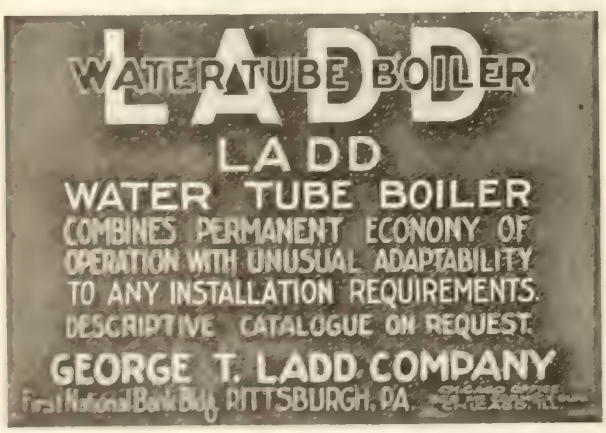

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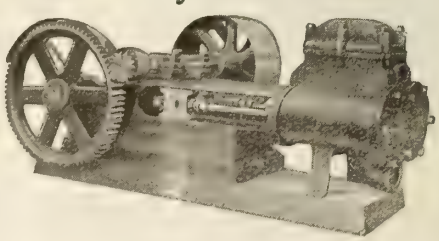

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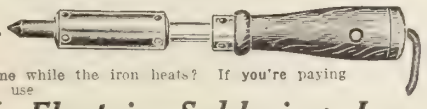

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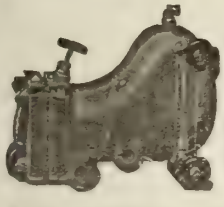

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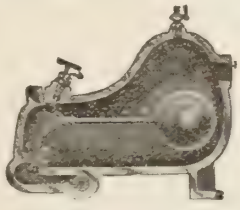

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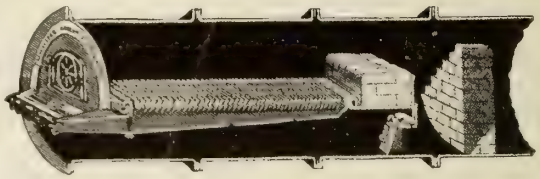

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If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS

Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS

Arthur S. Leitch Co., Ltd., Toronto.
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laidlaw Lamb, Montreal
MacGovern & Co., Inc., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Taylor Instrument Co., Toronto, Ont.

AIR METERS

Bailey Meter Co.

ALLOYS, BRASS AND COPPER

Kerr [illegible] Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS

Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Johns-Manville Co. Ltd., Toronto.

AMMONIA PLANT EQUIPMENT

Can. Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa
York Mfg. Co., York, Pa.
Underfeed Stoker Co. of Canada, Ltd., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFING

Can. Johns-Manville Co., Ltd., Toronto

ASBESTOS SPECIALTIES

Feldtam Asbestos (Canada) Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
[illegible] N.Y.
[illegible] Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.
[illegible] Hagerstown, Md.

AUTOMATIC MECHANICAL STOKERS

Canadian Planet Engineering Co., Windsor, Ont.

AUTOMATIC DAMPER CONTROLS

Underfeed Stoker Co. of Canada, Ltd. Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL

[illegible] Montreal
Magnolia Metal Co., Montreal
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BACK PRESSURE RELIEF VALVES

[illegible] Ltd. Toronto, Ont.

BALL COCKS

Jas. Morrison Brass Mfg. Co., Toronto
[illegible]

BAKERS' OVENS AND REPAIRS

[illegible] Co., Toronto.

BAROMETERS

Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES

Canadian [illegible] Co., Ltd., Toronto.

BEARINGS

Kerr Engine Co., Walkerville, Ont.
[illegible] Philadelphia, Pa.
[illegible] Ont.
Northern Electric Co., Ltd., Montreal.

BEARING METALS

Beveridge Supply Co., Montreal.

BELT CEMENT

D. K. MacLaren, Ltd., Montreal, Que.

BELTS

Jas. Morrison Brass Mfg. Co., Toronto.

BELT CONVEYORS

Can. Link-Belt Co., Toronto, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELT DRESSING

D. K. MacLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Shell Bar Boico Supply, Ltd., Toronto.

BELT HOIST

Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER

D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELT TIGHTENERS

Waterous Engine Works Co., Brantford

BELTING, BALATA

D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, CHAIN

Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR

Gutta Percha & Rubber Co., Limited

BELTING, GRAIN ELEVATORS

Gutta Percha & Rubber Co., Limited

BELTING LINK

Waterous Engine Works Co., Brantford

BELTING, LEATHER

Can. Fairbanks-Morse Co., Ltd., Montreal
Gurlock Packing Co., Hamilton, Ont
D. K. MacLaren, Ltd., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, ORE ELEVATORS

Gutta Percha & Rubber Co., Limited

ARCHES

Canadian Fairbanks-Morse Co., Ltd., Montreal.

BELTING, RUBBER

Canadian Johns-Manville Co. Ltd., Toronto.
Can. Consol. Rubber Co, Ltd., Montreal
Gutta Percha & Rubber Limited, Toronto
D. K. MacLaren Ltd., Montreal Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, STITCHED COTTON DUCK

Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, STITCHED COTTON

D. K. MacLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal

BELTING, SOLID WOVEN

D. K. MacLaren, Ltd., Montreal, Que.

BELTING, TRANSMISSION

Gutta Percha & Rubber Co., Limited
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BINS, COAL, COKE AND ORE

Waterous Engine Works Co., Brantford.

BLOWERS

The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co., W. R., Toronto.

BLOWERS, CENTRIFUGAL

The Mason Regulator & Eng., Co., Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT

Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.

BLOWERS, MECHANICAL SOOT

[illegible] Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa

BLOWERS, TURBINE

Canadian Sirocco Co., Ltd., Windsor, Ont.
[illegible] Machine Works, Frankford, Philadelphia, Pa.
The Mason Regulator & Eng. Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS

Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

CHAIN WHEELS

The Mason Regulator & Eng. Co., Ltd. Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED

Can. Link-Belt Co., Toronto, Ont.

BOILERS

Gelinas & Pennock, Reg'd, Montreal.

BOILER COMPOUNDS

Beveridge Supply Co., Montreal.
Shell Bar Boico Supply, Ltd., Toronto
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply, Ltd., Toronto.

BOILER COVERINGS

R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER CLEANING EXTRACT

R. C. Miller Oil & Supply Co., Ltd., Montreal

BOILER FRONTS

Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS

Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILER REGULATORS

The Mason Regulator & Eng. Co., Ltd. Montreal.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER COMPOUND FEEDERS

Can. Fairbanks-Morse Co., Ltd. Montreal
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa

BOILER FITTINGS

Crane Ltd., Montreal
Lunkenheimer Co., Cincinnati, Ohio
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS

Northern Equipment Co

BOILER SETTINGS

Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W. R., Toronto
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS

Beveridge Supply Co., Montreal.

BOILER MOUNTINGS

Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto

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Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd, Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Sexton Boiler Setting Co., W. R., Toronto
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER

Crane's Limited, Montreal.

BOILER SETTING CEMENT

Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE

The Mason Regulator & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa
Engineering and Machine Works of Can., Ltd. St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
[illegible] Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons, Ltd., E., London, Ont
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE

W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa

BOILER TUBE PROTECTORS

C. B. Turner, Toronto.

BOXES, FUSE AND METER

Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS

Mueller Mfg. Co., Ltd., The.

BRASS GOODS

Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS

D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE

Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED

Can. Mead-Morrison Co., Ltd., Montreal.

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York Manufacturing Co., York, Pa.

BUSHINGS

Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE

Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS

Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE

Jas. Morrison Brass Mfg. Co., Toronto

CANNERS' CONVEYORS

Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY

Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia

CASTINGS, BRASS AND IRON

Bovine Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS

Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia. Ont.

CEMENT MACHINERY

Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford

CEMENT HANDLING MACHINERY

Can. Link-Belt Co., Toronto, Ont

CEMENT: HIGH TEMPERATURE

Betson Plastic Fire Brick Co., Inc., Rome N. Y.
International Chemical Co., Toronto, Ont
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply, Ltd., Toronto.
Gelinas & Pennock Reg'd. Montreal.

CHAINS, FOR ELEVATORS AND CONVEYORS

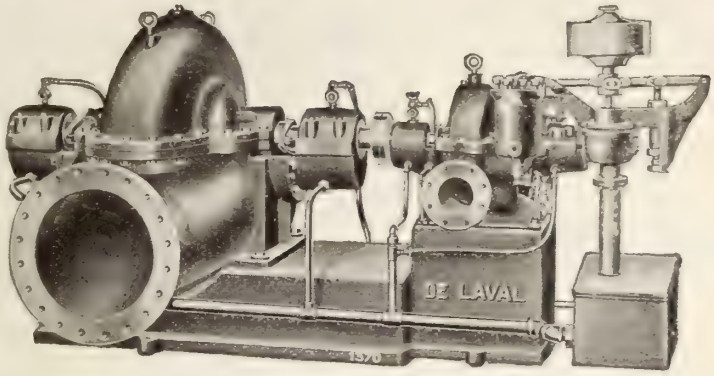
Can. Link-Belt Co., Toronto, Ont.

Turbine Driven Blowers
Must Be Rugged

THE DE LAVAL TURBINE-DRIVEN BLOWER unit shown is designed for gas plant work. It serves, however, to illustrate the care taken in designing De Laval apparatus to insure continuous, satisfactory service. Note the heavy construction of all parts, including the blower casing, also the forced lubrication with sight feed and the powerful and accurate speed governor, all features contributing to reliability in operation.

The same features are apparent in the design of all other De Laval apparatus, including turbine-driven generators, centrifugal pumps, blowers and compressors, speed-reducing gears, geared turbines for rope and belt drive, etc.

State class of apparatus in which you are interested and appropriate literature with special data will be supplied. Ask for Catalog F-100.



De Laval velocity-stage turbine driving single stage gas blower 11,000 cu. ft. of free air per min. against 33 in. water column at 3,600 R. P. M.

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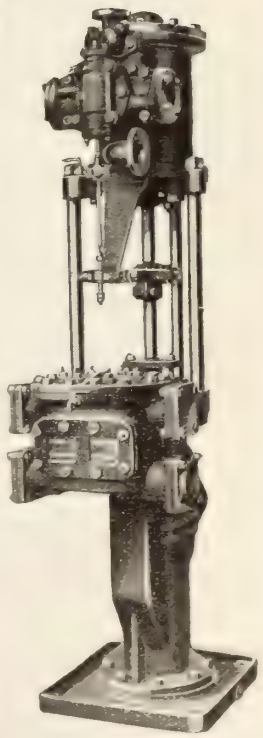

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Yarnall-Waring Co., Philadelphia, Pa.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
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Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
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Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
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MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
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York Manufacturing Co., York, Pa.

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Armstrong Cork & Insulation Co., Montreal Que.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

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Laurie & Lamb, Montreal

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Bowing Hydraulic & Eng. Co., Ltd., Lindsay, Ontario.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

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Montreal.

CONDUITS
Canadian Johns-Manville Co. Ltd., Toronto.

CONDENSATION RECEIVER
The Morris Regulator & Eng. Co., Ltd., Montreal.

CONNECTIONS, FLANGED
Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N.Y.

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MacKinnon Steel Co., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox Ltd., Montreal

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Godfrey Conveyor Co., 106-116 Richmond St. West, Toronto.
Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Brantford.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUPLINGS
Bowing Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach. Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Bowing Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Bowing Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Limited.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

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Jamison Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRILL RODS
Lincoln Electric Co. of Can., Ltd., Toronto

DROP- FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Montreal.

EJECTORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co. Ltd., Toronto.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.
B. F. Sturtevant Co., Boston Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
MacKinnon Steel Co., Ltd., Sherbrooke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg. Co., Toronto.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Frick Co., Waynesboro, Franklin Co., Pa
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Bowing Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont

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Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont
Sturtevant Co., B. F., Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N.Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N.Y.
Jas Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N.Y.

EYE BOLTS

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Sturtevant Co., B. F., Toronto, Can.

FAN ENGINE REGULATORS
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co., Montreal, Que.

FEED WATER PURIFIERS
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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
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S. F. Bowser Co., Ltd., Toronto, Ont.
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Mason Regulator & Eng. Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Mackinnon Steel Co., Ltd., Sherbrooke,
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittburgh, Pa.
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATION SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

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Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

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Beveridge Supply Co., Montreal.
Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
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Beteon Plastic Fire Brick Co., Inc., Rome, N. Y.
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Crane's Limited, Montreal.

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Crane's Limited, Montreal.
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Jas. Morrison Brass Mfg. Co., Toronto.

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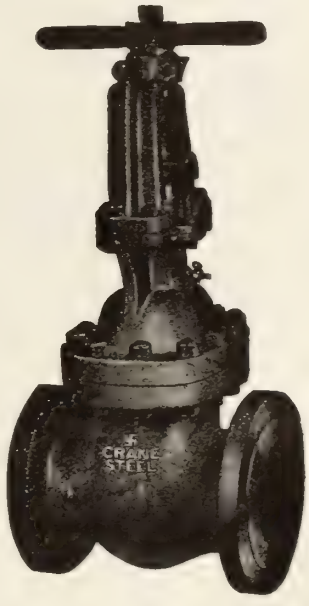

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Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

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Johns-Pratt Co., The, Hartford, Conn.

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Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

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Babcock & Wilcox, Ltd., Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

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Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

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Arthur S. Leitch Co., Ltd., Toronto.

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Sturtevant Co., Ltd., B. F., Galt, Ont.

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Mason Regulator & Eng. Co., Ltd., Montreal.
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Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

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Can. Mead-Morrison Co., Ltd., Montreal.

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Gelinas & Pennock, Reg'd, Montreal.
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Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd. Montreal.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto.

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Canadian Steam Boiler & Equipment Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio
Penberthy Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply, Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
W. R. Sexton Boiler Setting Co., Toronto.
R. C Miller Oil & Supply Co., Ltd., Montreal

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American Steam Gauge & Valve Mfg. Co.
Arthur S. Leitch Co., Ltd., Toronto.
Boston, Mass.
Laurie & Lamb, Montreal.

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S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd. Hamilton

Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

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Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co. Ltd., Toronto.

HOSE RUBBER
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Pratt & Cady Co., Inc., Hartford, Conn.

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Frick Co., Waynesboro, Franklin Co., Pa.
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Frick Co., Waynesboro, Franklin Co., Pa.
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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Yarnall-Waring Co., Philadelphia, Pa.

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Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.

INSULATING COMPOUNDS
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INSULATORS
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KEROSENE TANKS
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Penberthy Injector Co., Windsor, Ont.
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Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
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PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.

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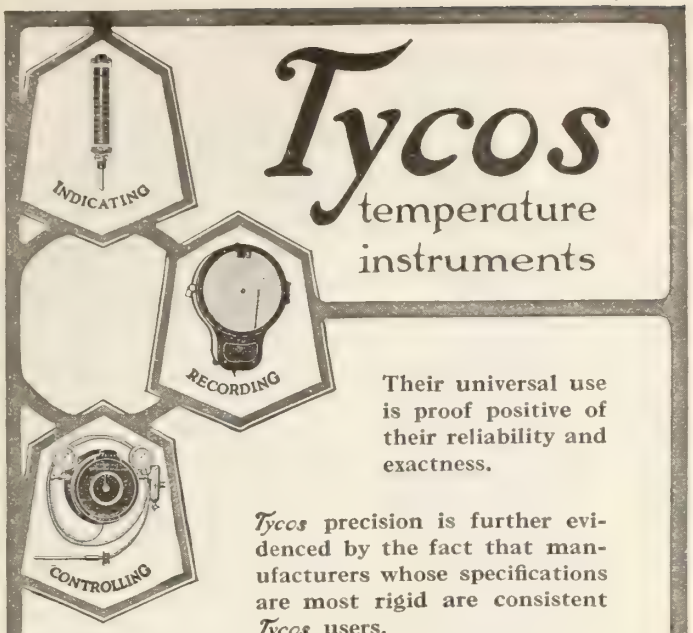

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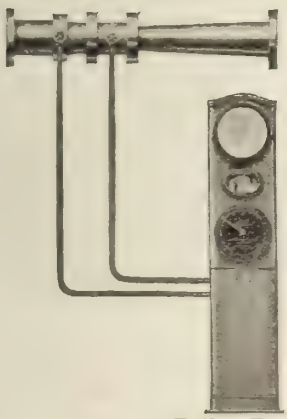
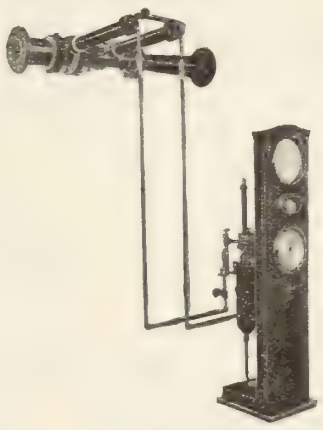


Venturi Boiler Feed Water Meter

1. How many pounds of water are evaporated for each pound of coal burned.
2. Which boilers are efficient and which need cleaning or repairs.
3. When a boiler can be cut out or another boiler should be put in service.
4. Whether or not the water tender is doing his work well.
5. Which kind and grade of coal is most economical for your boiler plant to use.
6. How much steam is used in the engine room.
7. How much steam is used for manufacturing processes.
8. How much steam is supplied for heating.
9. How much condensation is returned to the boilers.
10. How much circulating water is used by the condensers.



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Is not knowledge of these things vital for efficient power plant operation? The Venturi Meter is giving this information every day in thousands of power plants throughout the United States and Canada. Our accumulated experience in this field is at your disposal. Shall we send you further details?

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Lunkenheimer Co Cincinnati, Ohio.

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Canadian Johns-Manville Co. Ltd., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boiler Supply Ltd., Toronto.

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Flexible Metallic Packing Co., Windsor, Ont.
S. F. Bowser Co., Ltd., Toronto, Ont.

PACKING, OIL
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PAINTS
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MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

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The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Mfg Co., York, Pa.

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Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.
Lunkenheimer Co Cincinnati, Ohio

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg Co., Toronto

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
MacKinnon & Co., Inc., Montreal.
MacKinnon & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSURE REGULATORS
The Mason Regulator Co., Marshalltown, Iowa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

PULLEYS
D. K. McLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullough Co., Galt.
Waterous Engine Works Co. Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co,. Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, BILGE
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE) CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Smart, Turner Co., Hamilton, Ont.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co (Inc.), Marshalltown, Iowa

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co. Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's Limited Montreal.

RADIATOR TRAPS
Sarco Co. Inc New York, N.Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co Windsor, Ont.

RADIATOR VALVES
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boiler Supply Ltd Toronto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York Pa.

RECEIVERS, AIR
MacKinnon Steel Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

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Bailey Meter Co., Cleveland.
Canadian Johns-Manville Co. Ltd., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnal-Waring Co. Philadelphia, Pa.

RECORDERS CO2
Sarco Company Inc New York

RECORDING THERMOMETER AND GAUGES
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Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Taylor Instrument Co. Toronto, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd Toronto.

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Toronto, Ont.

REGULATING VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont

RETORTS
MacKinnon Steel Co Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

ROLLS, CRUSHING
Can Link-Belt Co Toronto Ont.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co Toronto Ont.

SCREENING MACHINERY
Can. Link-Belt Co. Toronto Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited Montreal

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co. Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co. Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

EXPANSION ENGINES SINGLE, COMPOUND AND TRIPLE
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co. Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co Ltd., Montreal

SOAP, POWDER
R. C. Miller Oil & Supply Co Ltd., Montreal

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd., Windsor, Ont

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co. Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co. Brantford.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.

STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN

All parts made to gauge and interchangeable. Give us opportunity to figure on your pumping requirements.

PACKED PISTON BOILER FEED PUMPS

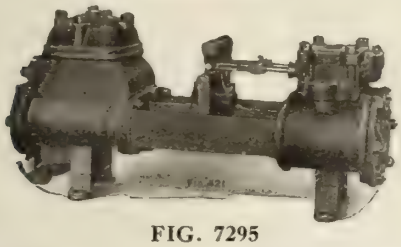


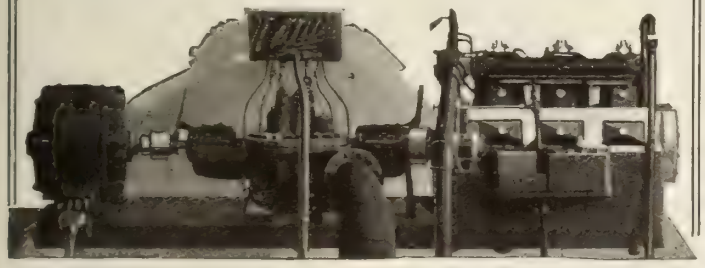
FIG. 7295

A wide range of steam and power-driven pumps for all conditions of service and for all industrial and public utility purposes.

Established 1852

THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

Conceded: that no transported power is absolutely certain. **Therefore:** a set like this assures water for fire fighting when, because of storms or mechanical difficulties, power is off.



6-cylinder Sterling engine supplementing electric motor at Lindsay, Ont., on 6″ 2 stage DeLaval pump, installed by Turbine Equipment Co., Toronto. Capacity 1,325 G.P.M. against 290 ft. at 1,450 R.P.M.

The gasoline engine is thrown in with a jaw clutch in case of emergency, such as hydro failure or fire. Costs $20 per H.P. Compare it with any other prime mover.

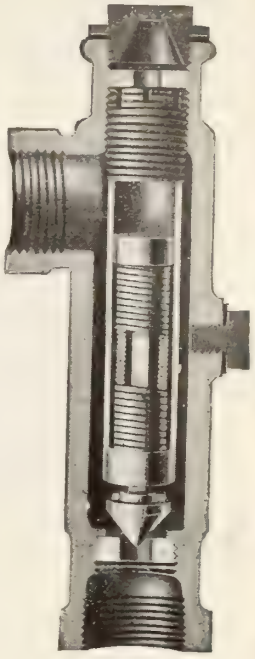
STERLING ENGINE CO.

Dept. C-4

BUFFALO, NEW YORK

12 to 300 H.P. 900 to 1,500 R. P. M.

In-Sufficient Trapping Is also In-Efficient



Not enough trapping is bound to be **inefficient trapping** —bound to result in waste of steam and therefore waste of coal and money.

In many cases, insufficient trapping and the resultant waste and inefficiency seems cheaper than paying the high price of a float or bucket trap, plus their high cost of installation—that's the only reason any up-to-date plant can have for not putting in traps at every point where condensation occurs.

But that reasoning doesn't apply to

STEAM TRAP

SARCO

Although a decided improvement over the old float and bucket traps, Steam Trap Sarco **costs only one-third as much**—and there is practically no installation cost whatever, because there is no building up required, and no platform or other support.

You can buy **three** Sarcos for the price of **one** float or bucket trap—thus, at the same cost, having traps at three points instead of only one. The cost of Sarcos is so small that there is no longer any excuse or justification either for in-sufficient or in-efficient trapping.

Steam Trap Sarco is a Valve, a By-Pass, a Check-Valve and a Steam-Trap all in one, and goes in like an elbow. So small that it can be installed where the big and cumbersome traps would be utterly out of the question. Takes only one-third as much space. Will outlast any old-style trap, and practically never needs adjustment or attention. Will go in the line at any point, at any angle, and without any change in the piping.

Sold on 30 days' free trial. Send for Booklet J-23.

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239 Broadway, N. Y. C.

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DETROIT PHILADELPHIA

STAND PIPES, STEEL

MacKinnon Steel Co.

STEAM JETS

Chicago, Ind.

STEAM SPECIALTIES

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Mfg. Co., Toronto.
Co., Windsor.
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STEAM METERS

Bailey Meter Co.

STEAM CALORIMETERS

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STEAM TRAP TOOLS

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STEEL BARRELS

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Pittsburgh, Pa.

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Pittsburgh, Pa.

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Sherbrooke, Que.

STOKERS

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Ltd., Montreal
Montreal
Chicago, Ind.
Stoker Co. of Canada, Ltd., Toronto
Toronto.
Boston, Mass.

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Marshall-
Montreal.
New York
Hamilton.
of Canada, Ltd. Toronto, Ont.

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Montreal.
Pittsburg, Pa.

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SUPERHEATER, STEAM

Montreal
Galt.
Montreal.

SUPERHEATER, STATIONARY

The Superheater Co., Ltd., Montreal.

SUPERHEATER, LOCOMOTIVE

The Superheater Co., Ltd., Montreal

SUPERHEATER, STEAM SHOVEL

The Superheater Co., Ltd., Montreal

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Brooklyn, N.Y.

SYPHONS

Co., Toronto.
Windsor, Ont.

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Co., Ltd.,
Toronto.

Sherbrooke.
Brantford.

TANKS

Toronto, Ont.

TANKS, BLOW-OFF

Montreal.
Brantford.

TANKS, BRINE

Pa.
Sherbrooke
Que.
Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING

Pa.
Que.
Pa.

TANKS, GASOLINE

Toronto
Que.

TANKS, OIL

Lindsay.
Toronto.
Galt.
Ont.
Montreal.
Pittsburg, Pa.
Brantford.

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Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford

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S. F. Bowser Company Ltd., Sherbrooke.

TANKS, WATER

Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCulloch Co. Galt.
Leonard & Sons Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

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Taylor Instrument Co., Toronto, Canada
ing Instrument Co., New York, N.Y.

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Sarco Co., Inc., New York, N.Y.

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MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal

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Moving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
Anderson Co., Y. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
J. T. Long, 94 Adam St., Montreal, Que.
Mason Regulator & Eng. Co., Montreal.
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.
Taylor Instrument Co., Toronto, Ont.

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D'Este Co., Julian, Boston, Mass.

TACHOSCOPES

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TRAPS

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American Steam Gauge & Valve Mfg. Co. Boston, Mass.

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Victoria Foundry Co., Ltd., Ottawa.

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Goldie & McCulloch Co., Galt.
Pilley Packing and Flue Brush Mfg. Co. St. Louis Mo.

TUBE CUTTERS

Babcock & Wilcox, Ltd., Montreal

TUBES, BOILER

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

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Mason Reg. & Eng. Co., Ltd., Montreal
B. F. Sturtevant Co., Boston, Mass.

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Engineering and Machine Works of Can
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MacGovern & Co., Inc., Montreal, Que.

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
B. F. Sturtevant Co., Boston, Mass

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Ltd., Montreal
Steel Union Company, Toronto.
Jas. Morrison Brass Mfg. Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.

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Reading Steel Casting Company, Inc., Reading Valve and Fittings Division, Bridgeport, Conn.

VALVES

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Dick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

VALVES, ACID RESISTING

Homestead Valve Mfg. Co., Pittsburg.
Kerr Engine Co., Walkerville, Ont
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
York Manufacturing Co., York, Pa

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Lunkenheimer Co., Cincinnati, Ohio.
H. Mueller Mfg. Co., Ltd., Sarnia.
Jas. Morrison Brass Mfg. Co., Toronto
Pratt & Cady, Hartford, Conn.

VALVES, BACK PRESSURE

Fisher Governor Co., Inc., Marshalltown, Iowa.
Pratt & Cady, Hartford, Conn.

VALVES, BLOW-OFF

Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Homestead Valve Mfg. Co., Pittsburg
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, HYDRAULIC

Pratt & Cady, Hartford, Conn.
Yarnall-Waring Co., Philadelphia, Pa.

VALVES, BRASS

Crane Limited, Montreal
D'Este Co., Julian, Boston, Mass.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator Co. Boston, Mass.
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Penberthy Injector Co., Windsor, Ont.
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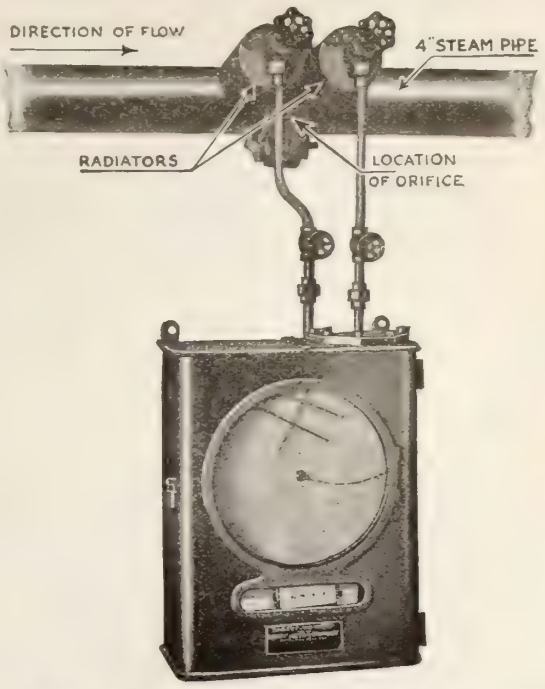

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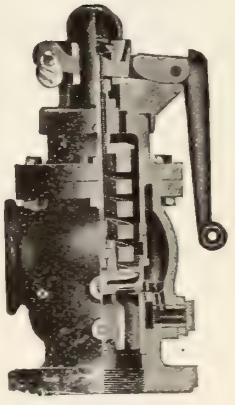

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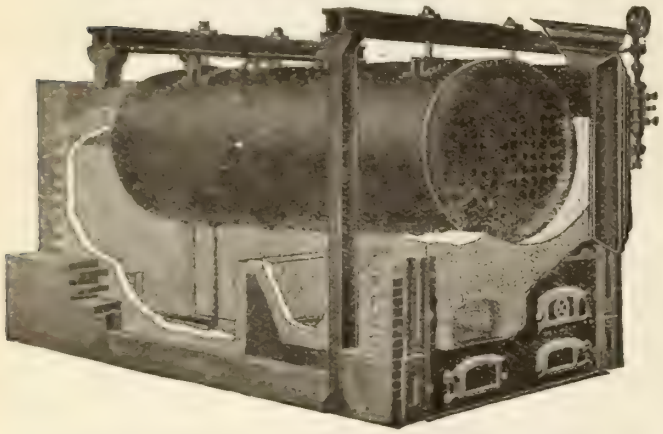

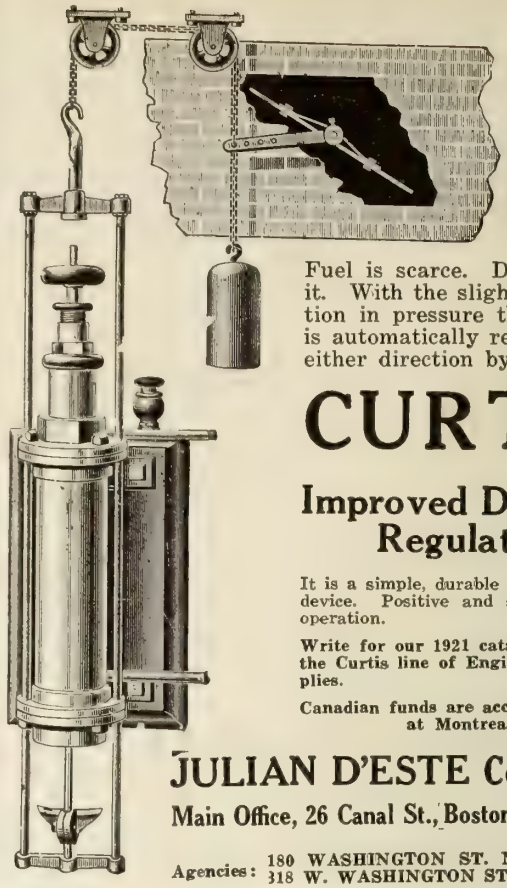

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Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

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PURIFICATION SYSTEMS
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FOR BOILER FEED AND
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A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL, WINNIPEG, VANCOUVER — LONDON, ENG.: 88 Fleet Street, E.C. — NEW YORK, BOSTON, CHICAGO

Vol. XV.—No. 7 — Publication Office, Toronto—April 5, 1922 — Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Coon Pond Dam showing spillway and intake.

St. Margaret's Bay Power Development

THE Hydro-Electric Power Plants of the N. S. Power Commission are comprised of three separate units.

The Mill Lake Plant has two dams, one 970 feet long with maximum height of 27 feet; the other 380 feet long, with maximum height of 30 feet. The intakes and headgates are housed in concrete gate-houses. Net operating head of this plant, 156 feet.

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The Tidewater Plant obtains its water partly from Indian River, partly from the Northeast River. Net operating head of this Plant will be 91 feet.

The generating stations at Mill Lake and Tidewater are of concrete, simple and artistic in design.

The engineers have taken advantage of the close contiguity of the two rivers, to utilize a large flow of water with the smallest possible number of generating units; such a layout providing maximum efficiency in hydraulic and electrical equipment by use of large units, with low operating expense and exceptional facility in operation.

The work is under the personal direction of Mr. G. R. Heckle, M.E.I.C., Vice-President of D. G. Loomis & Sons, Montreal, who are the general contractors. Messrs. C. H. and P. H. Mitchell, Toronto, are Consulting Engineers for the N. S. Power Commission. Mr. E. N. Armstrong is Chairman of the Commission and Mr. H. K. Smith, Chief Engineer.

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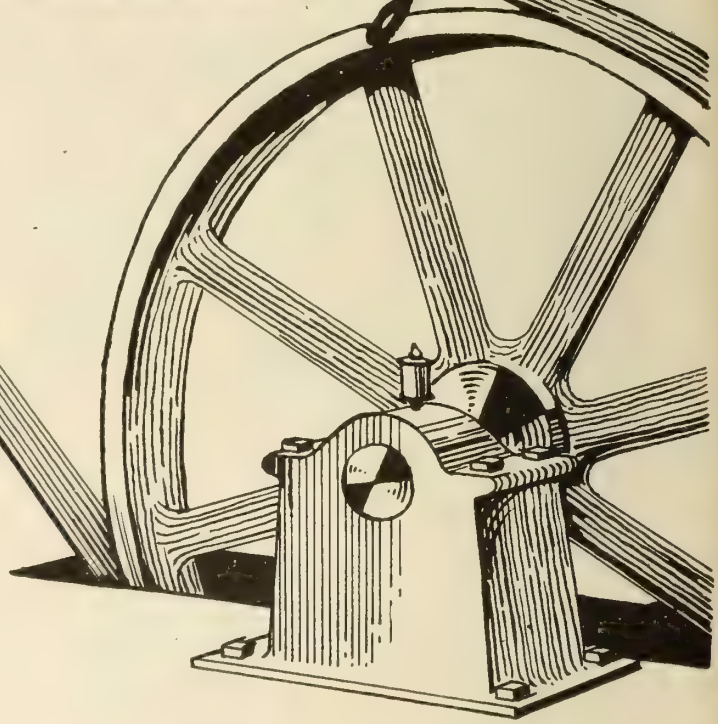

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Files Hand Stokers Getting Results

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GENERAL OFFICES AND FACTORIES
SHERBROOKE, QUE.

SHERBROOKE, CANADA September 23, 1921.

The Waterous Engine Works Co. Ltd.,
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Gentlemen:

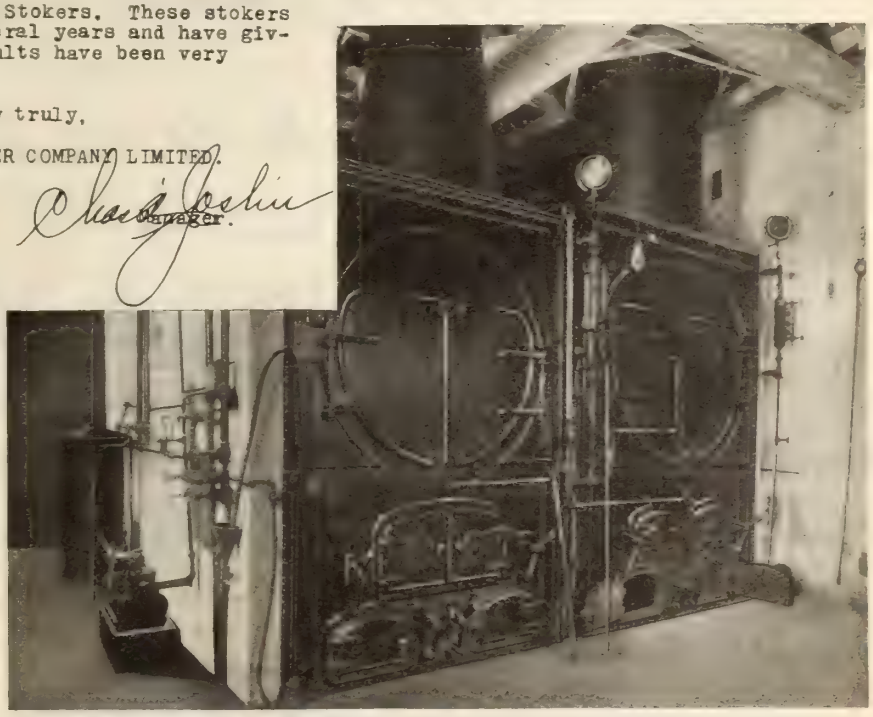
In reply to your letter of the 8th instant we have in our plant the Files Stokers. These stokers have been in operation for several years and have given excellent service. The results have been very satisfactory.

Yours very truly,

PANTHER RUBBER COMPANY LIMITED.

Manager.

CAJ/RMK



It is the uniform excellent service and general satisfaction that have caused progressive men to select **Files Stokers.** These are typical of the more complete data we have compiled:

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3. **Fuel bed continuously kept clean, uniform and rich.**

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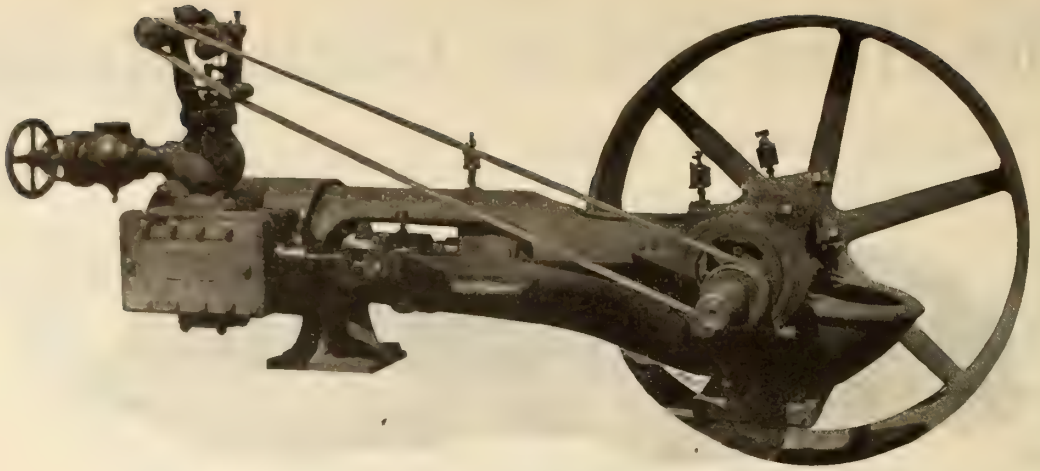
The Waterous Engine Works Company, Ltd.

Brantford, Ontario



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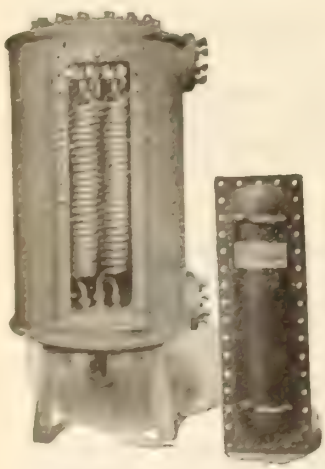

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New Truths and Old Fallacies

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It is easy to comprehend from the figures below, giving the specific gravity of certain metals, why a Genuine Babbitt does not separate when left in a molten state, because of the slight difference in specific gravities of its ingredients, and why a lead base metal does separate, because of the greater comparative weight of lead, if not occasionally stirred, when in a molten condition.

Metals	Specific Gravity
Tin	7.29
Antimony	6.62
Copper	8.93
Lead	11.35

The specific gravity of a metal represents its weight as compared with the same volume of water.

At one time there was considerable trouble caused from this separation of the ingredients, but now that knowledge is more general concerning it, there is rarely, if ever, complaint from that source.

(Continued next month)

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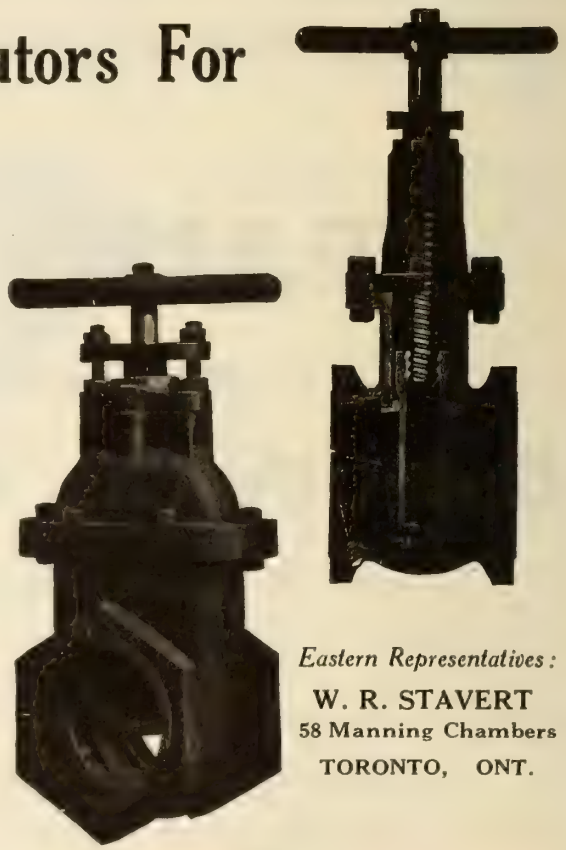

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Make your next installation "KERR" Valves. Let us send full particulars.

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Valve Specialists
Walkerville, Ontario

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PUTS AIR TO WORK

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It is the only unit made that performs both these functions — thoroughly and satisfactorily. Write us — there is an installation in your vicinity you would like to look over.

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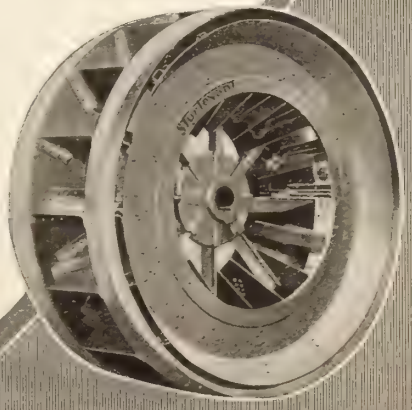

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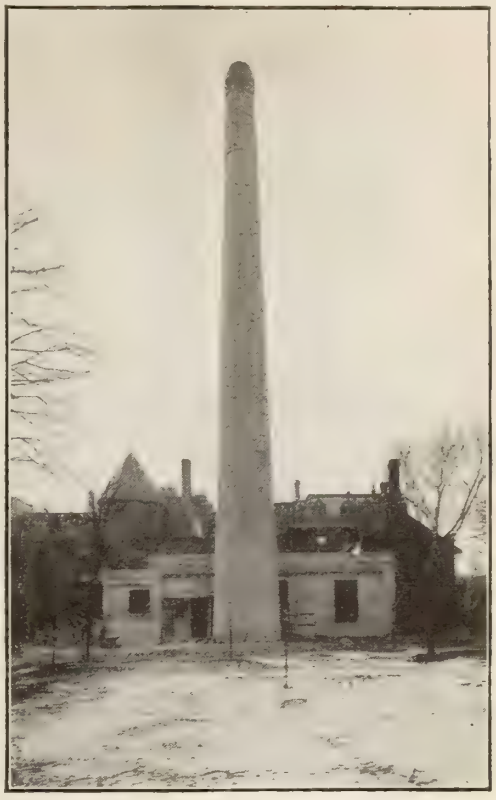
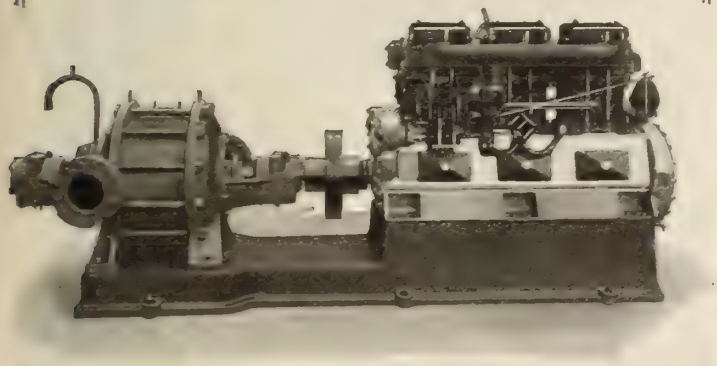


A recently-built Kellogg Chimney at House of Providence, Toronto.

A Typical Performance---52 Days at 1,400 Revolutions



Model GRC 6-cylinder STERLING at Traverse City, Mich., direct connected to Union Steam Pump Co., Battle Creek, Mich., centrifugal pump, capacity 1,000 G.P.M., 435-ft. head, speed 1,400 R.P.M., efficiency 72%, 153 B.H.P.

This unit averaged up to 12 hours a day **constant service** for 52 days and could continue indefinitely. This, on sluicing work for which steam was formerly employed. And it cost less than steam to buy, to install, to run. Figures gladly supplied.

Sterling Engine Company
Dept. C-4
BUFFALO ***NEW YORK***
12 to 300 H.P. *900 to 1,500 R.P.M.*

A FURNACE WALL LINING
that is free from joints, cracks, falling bricks and mortar.
Any workman can make this furnace lining.

Perfect Monolithic Boiler Arches

properly flared for easy firing, durably made with the genuine

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REG. U.S. TRADE MARK PLASTIC FIRE BRICK PAT. OFF.

Here is a splendid repair material for your present boiler furnace linings, as well as the proper thing to use for front and back arches and gas-tight baffles. Used by thousands of plants with continued satisfaction.

Write for booklet that tells of its usefulness in the boiler room.

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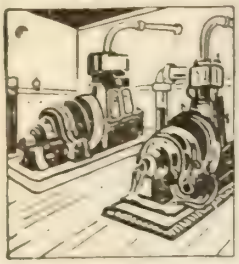
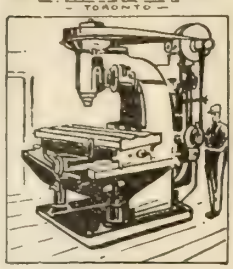
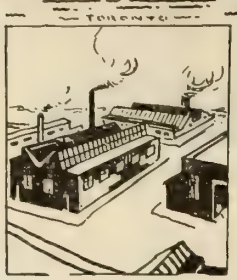
Canadian Distributors: INTERNATIONAL CHEMICAL CO.
4s-6 Lombard Street, Toronto, Ont., Canada







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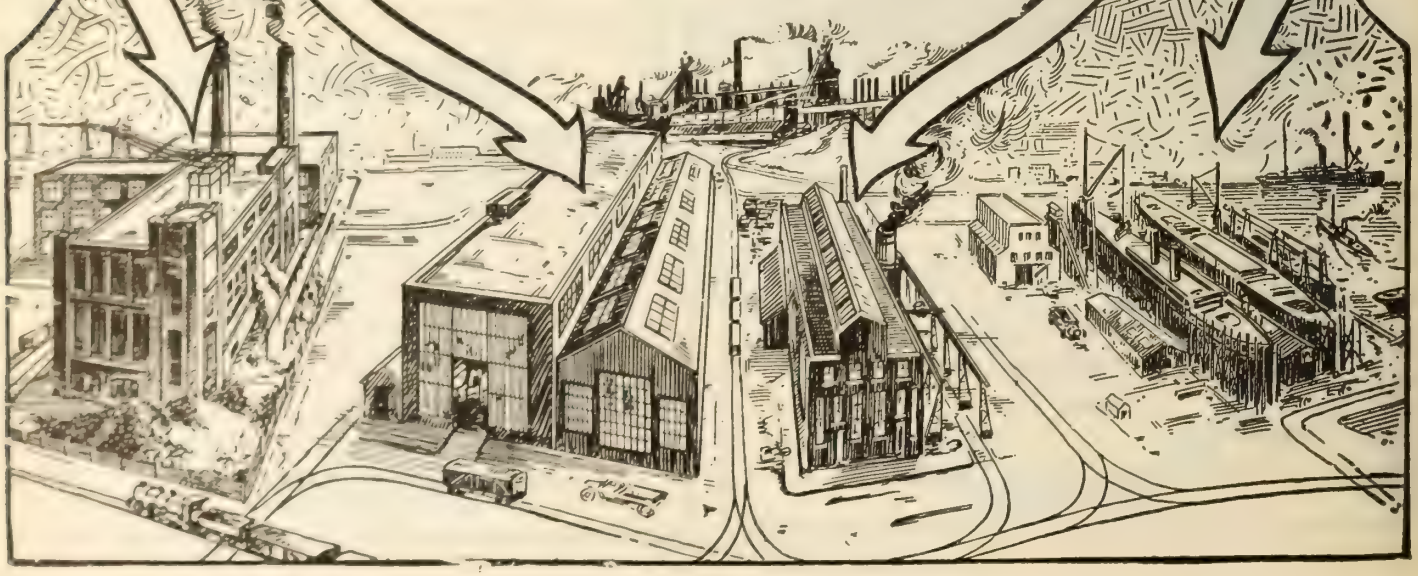

Under ideal conditions, with plungers smooth and absolutely in line, the prevention of leakage at stuffing boxes, when handling extremely hot water at high pressures, presents a definite problem.

When plungers are scored and out of line, a packing especially designed for such service will be found in Garlock style No. 443 combination. This packing will prevent leakage and give lasting satisfaction; the rubber cushioned flax and diagonal rings reacting to any lateral movement of the plunger with minimum friction.

Try style No. 443 on your feed pump plungers.

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Made in Canada

REFRIGERATING AND
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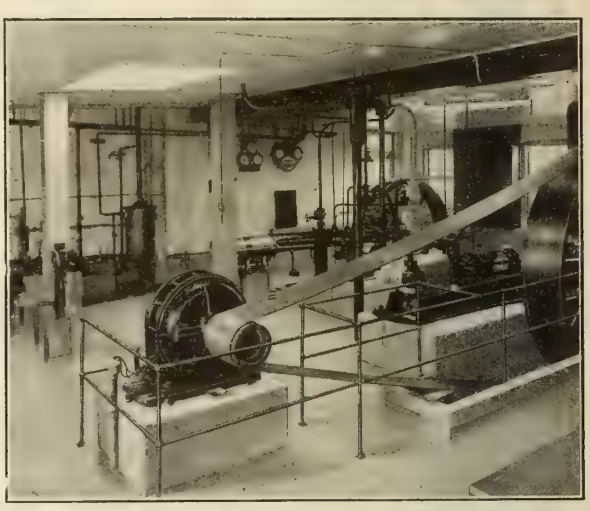
For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

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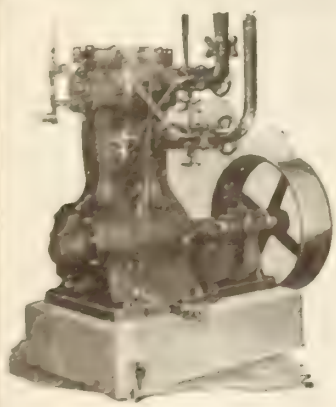

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Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.

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is built to operate satisfactorily under all practical conditions.

Our Vertical, Single-Acting, Two-Column, Belt-Driven Machines may be actuated by any available power. They are compact, strong, sturdy machines — scientifically designed. Built in sizes from 20 tons refrigerating capacity upwards.

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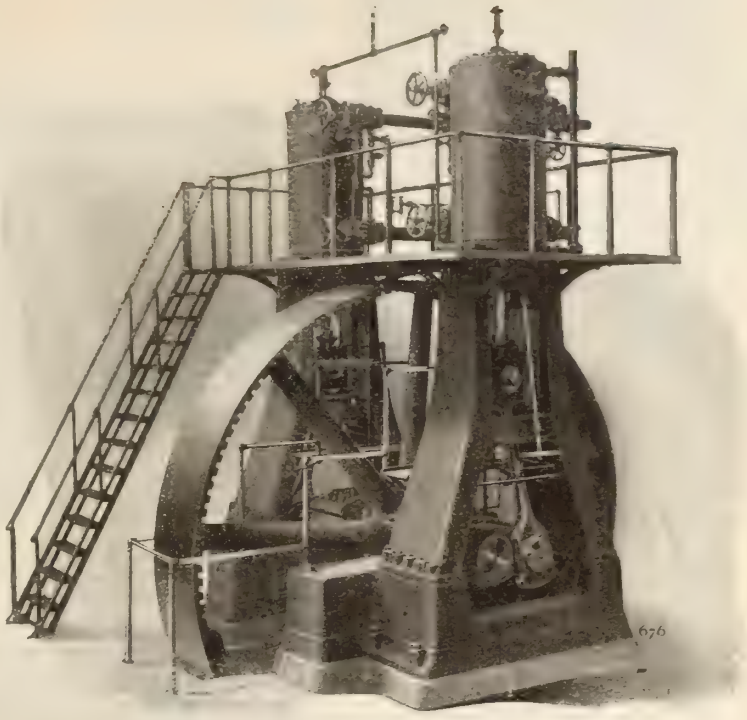

JAMISON
Formerly "JONES"

Heavy Duty Cold Storage Doors

In the **Jamison** line of cold storage doors you can get a door exactly suited to your requirements. Made for all conditions and purposes.

Shown here is our Standard Bunker Door—also our Entrance and Bunker Door combined. Special attention is drawn toward the Automatic Self-tightening Fastener and Adjustable Spring Hinges. They are heavier in construction and combine practical features not found in other doors. All hardware in Jamison doors is bolted to the door and frame; no wood screws used.

These are but a few of the features that have won for **Jamison** products the reputation of the **World's Standard** by their long, unfailing performance under all conditions.

Catalogue No. 10 gives complete details—shall we send it?

JAMISON COLD STORAGE DOOR CO.
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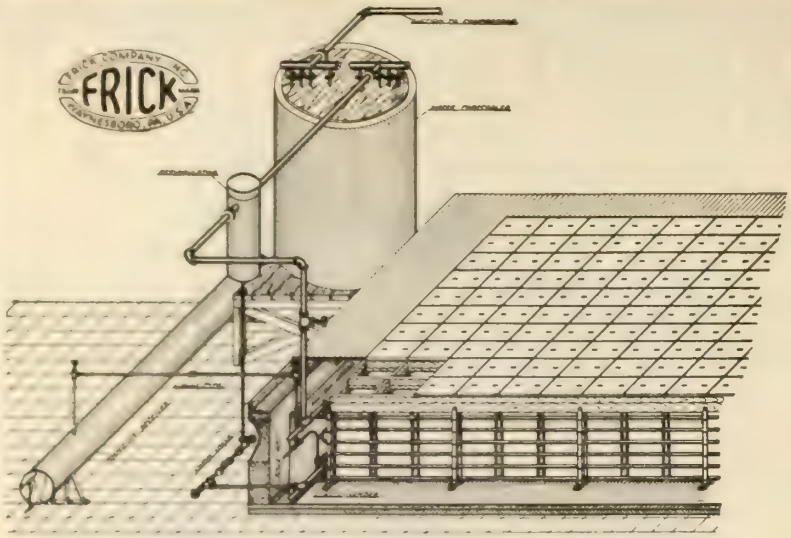

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Is a STANDARD Part of Every FRICK Plant

Its simplicity and dependability have made it a standard known the world over. Its success is unqualified.

It

Simplifies plant operation by reducing the number of feed valves to be regulated.
Increases plant efficiency by insuring uniform operation and giving absolute control of the ammonia.
Adds to plant safety by preventing priming accidents.
Lowers first cost of plant by increasing the heat transfer through the evaporating surface, thus reducing the amount of surface required.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

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ICE MACHINERY SUPERIOR SINCE 1882
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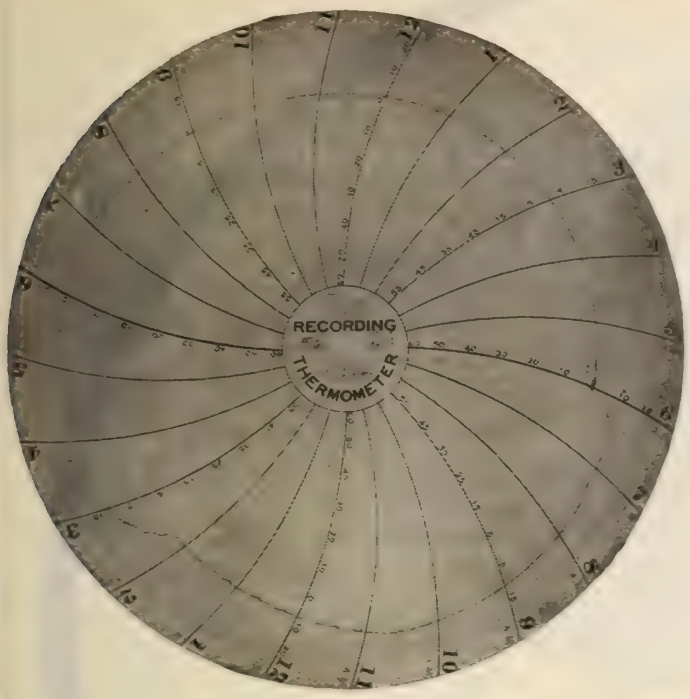


Thermometer chart from the hardening room of the Chapin-Sacks Corporation, Knoxville, Tenn., December 6, 1921.

What the Thermometer Told

THE overnight record (the upper half) of this chart is of unusual interest. Here are the facts:

Refrigeration was shut off at 6.00 p.m. with the temperature 12 deg. below 0 deg. F. At 11.00 p.m. the temperature was 1 deg. below 0 deg., a rise of eleven degrees due to absorption of refrigeration by the comparatively warm cream.

From 11.00 p.m. to 6.00 a.m. the temperature rose only to 0 degrees—1 degree in seven hours—in spite of the fact that the room was entered once during that period and cream removed.

Such a performance, while gratifying to the owners, is exactly what they expected when they insulated this room with six inches of Nonpareil Corkboard. They knew that the remarkable heat retarding property of Nonpareil Corkboard, by practically excluding outside heat, would fully protect their low temperature and afford the maximum operating economy. They knew also that, being non-absorbent, it would retain its efficiency and not deteriorate. In this, as in hundreds of other plants, Nonpareil Corkboard Insulation has justified the confidence of experienced users of refrigeration.

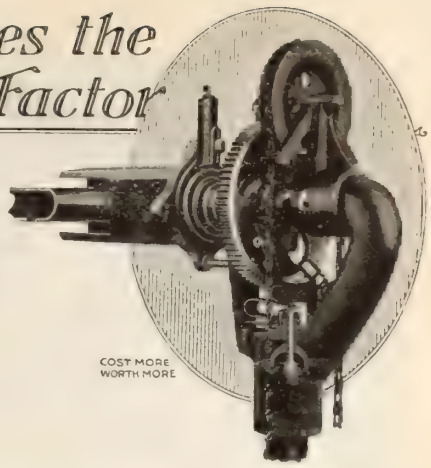
The importance of adequate insulation for low temperature rooms is fully explained in the 152-page book, "Nonpareil Corkboard Insulation," which you may have free of charge or obligation. Write for a copy.

Armstrong Cork & Insulation Company, Ltd.,
503 McGill Bldg., Montreal, Que 11 Brant St., Toronto, Ont.

NONPAREIL CORKBOARD INSULATION

For All Cold Storage Rooms

Eliminates the Human Factor



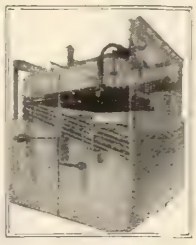
DIAMOND
VALV-IN-HEAD
SOOT BLOWERS

One of the appreciable factors in the efficiency and success of the Diamond Valv-in-Head Blower is that, compared to the independent valve soot blower, the number of manual operations is very greatly reduced and the opportunities for error in those performed are extremely limited. This is due to certain special features of design and construction.

Unit Full Floating—Any possible binding of the blower head, due to movement of the boiler under the forces of expansion and contraction, is prevented by a special mechanism which supports the unit in a spring suspension. As the blower head does not stick and bind there is never any temptation to the operator to pass by certain units in his rounds, or to fail to operate the blowers at scheduled intervals.

Reduction Gear and Ball Thrust Bearings—The reduction gear plays an important part in eliminating the uncertainties of the human factor. Boilers are only effectively cleaned when the steam jets play on the tubes for a pre-determined period of time. With the independent valve soot blower there is no means of controlling this time. The operator may revolve the unit as fast or slow as he pleases. Nine times out of ten he pleases to go too fast, with the result that the cleaning is not as effective as it should be. With the Valv-in-Head Soot Blower the reduction gear so regulates the speed of the blower element, and the ball thrust bearings minimize friction to such an extent, that improper operation is practically impossible, and all tubes are equally and thoroughly cleaned.

Elimination of the human factor is only one of eleven important advantages of Diamond Valv-in-Head Soot Blower. Every boiler needs a mechanical soot blower and you will save money by buying the best.



With the Diamond Valv-in-Head soot blower system, a saving is effected of practically two-thirds in the actual length of pipe required. The elimination of expensive individual control valves in favor of the Valv-in-Head is an important cost consideration. This decreases the initial cost of these items by half or more and reduces radiation losses from the soot blower lines by the same amount.

Diamond Valv-in-Head Soot Blowers are described and illustrated in detail in our new Bulletin 287. Write for your copy.

Diamond Specialty Co.

WINDSOR - ONTARIO

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

Long Life is Built Into ABC Vertical Engines

Compact and sturdy—demanding little attention—A B C Vertical Self-Oiling Engines are particularly adaptable for the operation of blowers, generators, pumps and other units.

It is not unusual for A B C Engines to operate continuously for a generation—and scores of engines are performing satisfactorily after having given reliable service for 10, 15 and 20 years.

A B C Engines are economical and will save their original cost in a short time out of the difference in the cost of operation as compared to ordinary horizontal steam engines.

The automatic oiling system reduces the consumption of oil to only about one-fifth of the usual amount.

We will gladly send you complete information regarding A B C Engines and will refer you to plants in your locality where these units have given never-faltering, economical service over a long period of years.

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BRANCH OFFICES IN ALL PRINCIPAL CITIES

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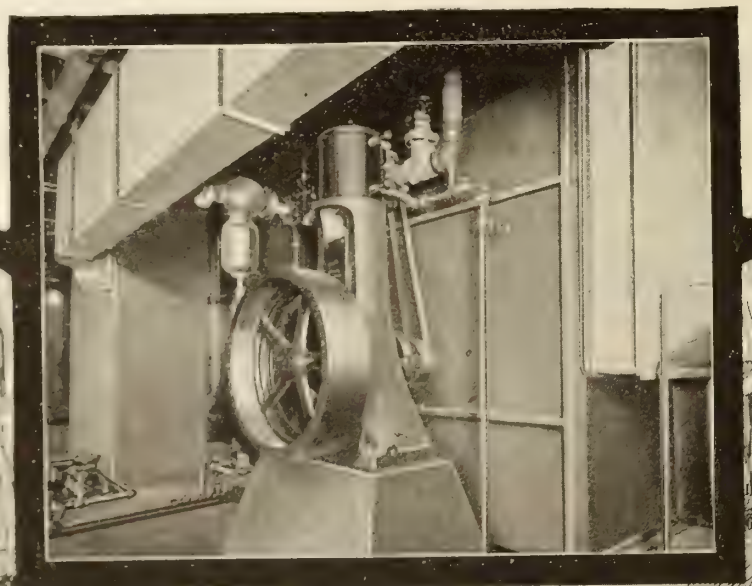

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FOR HEATING, VENTILATING, DRYING,
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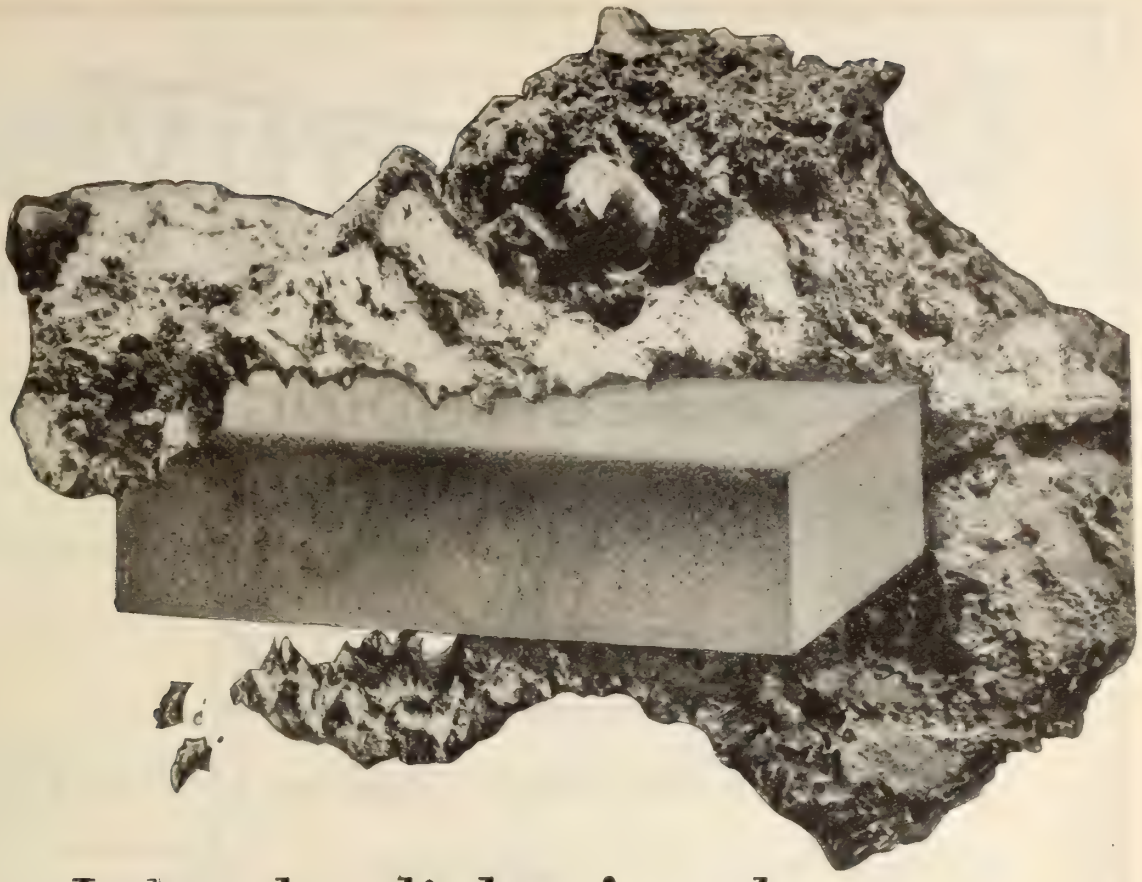

It breaks clinkers' teeth and saves your boiler setting

THE clinker attacks unprotected brick in fire-box walls with a vicious bite. Once it has penetrated, its bull-dog grip can be broken only at the cost of slicing away part of the brick and the mortar between.

But Johns-Manville Heat Treatment gives a clinker no opening for a hold.

The brick edges are not exposed, because No. 26 and No. 31 High Temperature Cements do not fall out from between the bricks. These cements have high tensile strength, and their elasticity allows for expansion and contraction without loosening.

For complete protection an additional over-all coating of No. 32 High Temperature Cement prevents clinkers from clamping on to the face of the brick.

Johns-Manville Heat Treatment strengthens your fire-box walls at their most vulnerable points. In reducing the item of boiler setting renewals and consequent shut-downs, it brings about a welcome economy.

CANADIAN JOHNS-MANVILLE CO., LTD.
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JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

and its allied products

INSULATION *that keeps the heat where it belongs*
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FIRE PREVENTION PRODUCTS

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Guaranteed for 200 lbs. pressure

COMPODISK

An all purpose disk valve. Working pressure 175 lbs.

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A 150 lb. Gate Valve. Solid Wedge. Non-rising Stem

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A high grade Radiator Valve in keeping with our other valves. Every valve tested. Every Valve with External Thread construction at Bonnet. Send for valve catalog.

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Something Better in Valves **VALVES** Made in Canada

JONES "A-C" STOKERS

It's the cost of stoker *service* that counts---

PLANTS that have installed Jones "A-C" Stokers have found that the most expensive stoker is the hand stoker. Why? Because the cost of hand firing per ton of coal fired is excessive and beyond reason. Yet there is no first cost to hand firing.

Bear this in mind in selecting a mechanical stoker to overcome the exorbitant expense of hand firing. Forget first cost and choose the stoker that costs least per ton of coal fired.

The records of Jones equipped plants prove that there are a number of sound reasons why you buy your stoker service cheaper when you choose the Jones "A-C." It will save MORE coal—by burning a wide range of poor coals with high efficiency. The Jones under-feed principle insures that. It will give greater boiler capacity—by carrying heavy overloads continuously. It will save in maintenance costs, for it is the simplest, most rugged high-duty stoker.

The new "A-C" catalog will convince you that stoker service costs least per year when you operate the Jones "A-C." Where shall we mail your copy?

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81 Victoria Street, Toronto

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The Cleaton Co. (Canada), Ltd.,
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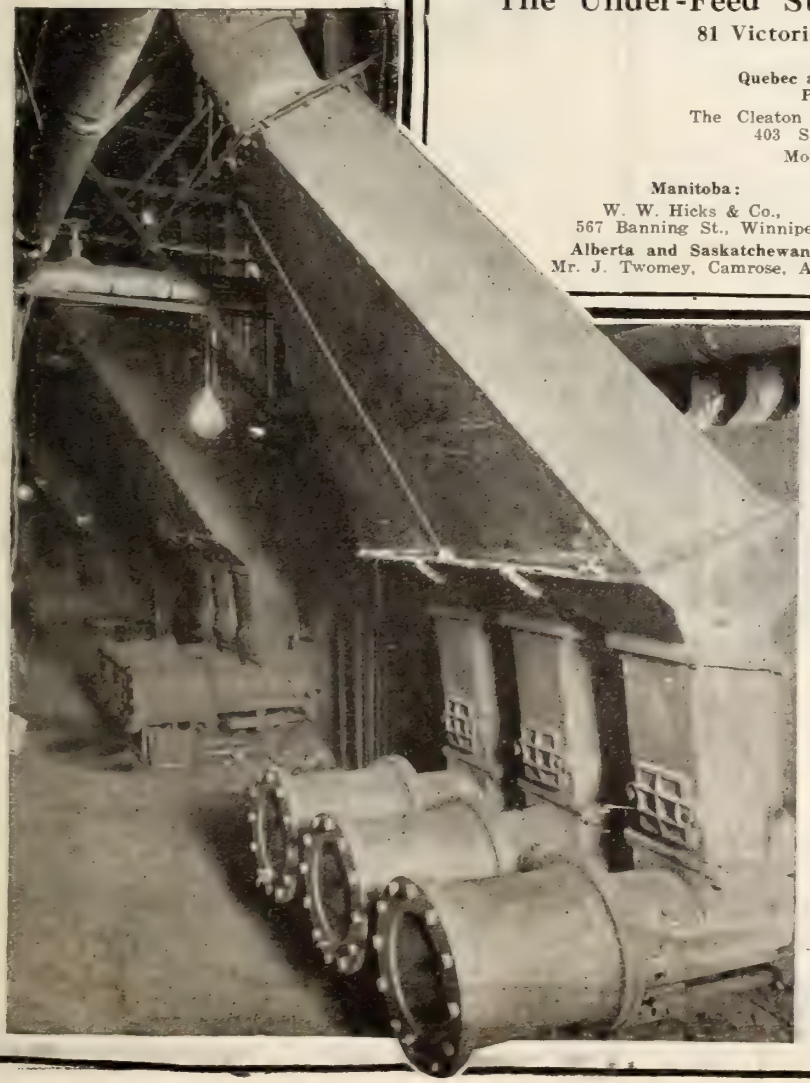
Alberta and Saskatchewan:
Mr. J. Twomey, Camrose, Alberta.

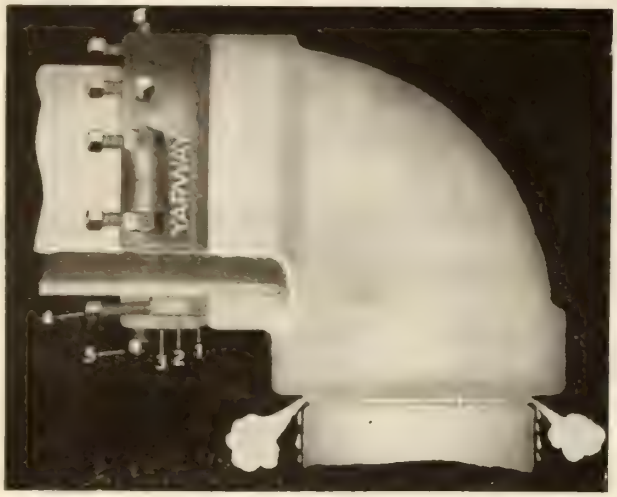
British Columbia:
E. A. Earle, Limited,
729 Hastings St. W.,
Vancouver, B. C.

Jones "A-C" Stokers in a Prominent Plant



The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. Through special arrangement the extensive engineering resources of the Under-Feed Stoker Co., of America are made available for Canadian power users. Thus, this strictly Canadian stoker is backed by world-wide experience and unequalled engineering ability.



YARWAY PIPE-JOINT CLAMP

Description: 1, Square packing ring, forced against leaky joint 2, bronze ring, forced against packing 1 by screws 4. 3, Outside ring, secured to pipe by bolts 6, secured by set screws. 5, prevents slipping when adjusting screws 4.

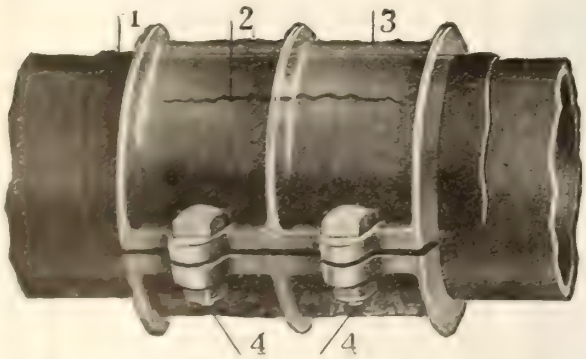
Stop That Costly Leak
with a
Yarway Pipe Clamp

Leaky pipe-lines waste thousands of dollars every year—needlessly. The YARWAY PIPE-JOINT CLAMP and the YARWAY HOLTITE PIPE CLAMP will stop nearly any leak in a few minutes, at small cost. The YARWAY PIPE-JOINT CLAMP stops leaks in threaded joints; the YARWAY HOLTITE PIPE CLAMP stops holes and splits in straight pipe. Either can be applied by any workman—no need for a shut-down. For temporary or permanent repairs, they give perfect satisfaction.

Both clamps are made in all the usual pipe sizes from ½" to 24", and stocked by dealers in all principal cities for immediate shipment.

Write to-day for your copy of Booklet C-805, containing description, prices and users' comments.

25,000 Sold.



YARWAY HOLTITE PIPE CLAMP

Description: 1, 2, 3, pipe split in halves. 4, 4, bolts to draw clamp and hold it in place.

·YARNALL·WARING·COMPANY·
604-20 Queen Street
Chestnut Hill··Philadelphia
Representatives in all Principal Cities
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YARWAY
POWER PLANT DEVICES

Do You Know?
Do Your Men Know?

Columbia
Recording Thermometers

—and Recording Gauges have daily charts with bright red record lines that show every temperature variation. These records must be read by the workman. If he doesn't the exclusive "Time Punch" attachment tells against him.

A full line of Thermometers, Gauges, Tachometers, Draft Gauges, etc., at our Toronto Office.

"Columbia" Recording Thermometers equipped with "Time Punch" for all temperatures up to 1000° F.

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Makers of instruments for the promotion of efficiency in Power Plant and Manufacturing Departments.

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TORONTO, ONT.
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"Jenkins Valves Only"

says Pilkington's Chief Engineer

Fig. 106
JENKINS BRASS GLOBE VALVE
Standard Pattern

Knowing valves and valve requirements he prefers Jenkins Diamond-Marked Valves because he has seen them in service, year in, year out —ever dependable and free from trouble.

In big manufacturing plants like that pictured above, dependable valves are all important.

That is why Canada's leading engineers regard the installation of Jenkins Valve as a paying investment. Genuine Jenkins pay for themselves in savings of time, labor and replacement charges.

There's a Jenkins Valve for every requirement of Power Plant, Industrial and Domestic service. The complete line is shown in Catalog No. 8.

Write for free copy.

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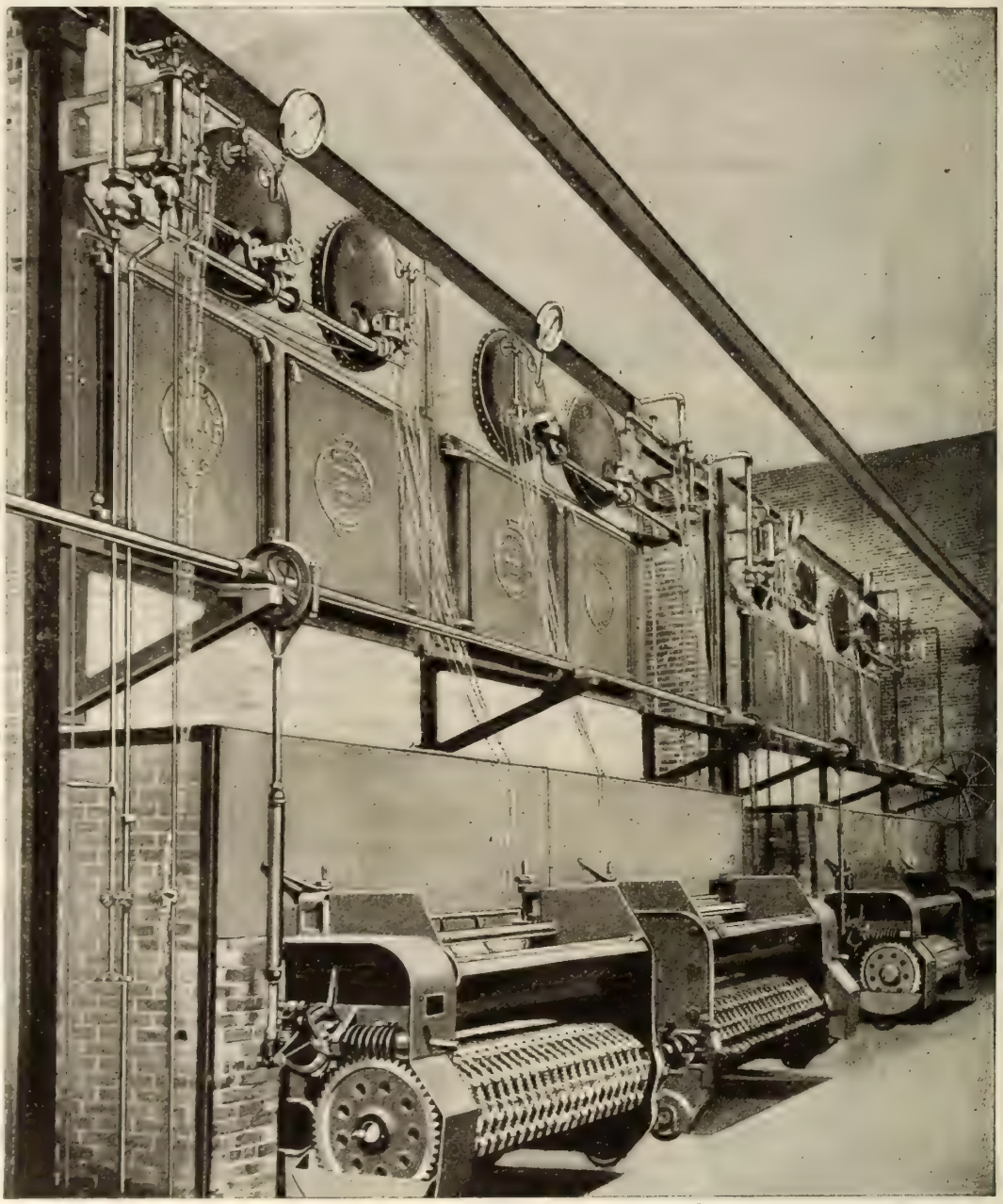
EUROPEAN BRANCH: 6 GREAT QUEEN ST. KINGSWAY LONDON W.C.2. ENG.
AGENCIES IN ALL THE PRINCIPAL COUNTRIES OF THE WORLD

G. & McC. SECTIONAL WATER TUBE BOILERS

Are to be found in Canada's leading Power Plants



The Boiler Room of the Saskatchewan Provincial Parliament Buildings at Regina equipped with 4 G. & McC. Double Drum Sectional Water Tube Boilers.

These Boilers will give you increased steaming capacity and more rapid circulation ;—Ask for Catalogues, Prices, etc.

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Refrigeration Talks in Plain Language

The Application of Mechanical Refrigeration to Industry is Getting Wider Every Day. Every Power Plant Engineer Should Endeavour to Understand the Basic Theories—He May Have to Apply Them at Any Time

By T. H. FENNER

OF ALL the aids to comfort which modern civilization enjoys, there are perhaps none that take a higher place than refrigeration. It is used in many widely diversified activities, from the storing of food to the storing of fur coats, and its aid is called in for the production of the films which we see in our favorite picture show. Its use in industry is increasing year by year, and a knowledge of its principles and practice is demanded now from every one who aspires to a responsible position as a stationary engineer.

There is no lack of literature on the subject of refrigeration, and it covers the most advanced as well as the most elementary aspects of the subject. It is a fact, nevertheless, that there are a large number of men who have no knowledge of this most important branch of the stationary engineering profession, and who by their lack of experience, are handicapped in the choice of suitable books on which to begin. It is therefore the purpose of the writer to give a series of articles, of which this is the first, covering the principles and practice of refrigeration in a way to be understandable to the novice, and at the same time, perhaps be of interest to those of more experience.

The Basis of Refrigeration

The stationary engineer, who begins to study, finds out very early in his progress that there is a theory which he must understand and understand very clearly, if he is to grasp the principles of the machine he handles. That is the theory of heat, and in his daily work he is surrounded by evidences of the application of this principle, and has ample opportunity to see the abstract idea in concrete form. Practically the whole theory of heat has been embodied in an axiom or law, which is called the first law of "Thermo Dynamics." Thermo Dynamics is the name given to the laws which govern the application of heat to the generation of mechanical power or movement. The law states "Heat and work are mutually convertible, and every unit of heat, requires for its production, or gives up by its disappearance, 778 foot lbs. of work." Now if we examine these words closely, we find that they mean simply this. Heat and work are two forms of the same thing. If one form appears, the other disappears. If we perform work, we expend energy and create heat. If we expend heat, we get its equivalent in energy, and we can then perform work. Now these are abstract words. Let us look at the units by which we measure these different things, and see how they are related.

The Unit of Heat and Work

Heat itself is a form of motion. It is not a substance, although its effects are substantial enough, and can be both seen and felt through the senses. The first conception of heat by the early scientists was that of an actual fluid, which in some mysterious manner passed in and out of various substances, causing changes of temperature and condition. By long and careful investigation that theory was proved to be a wrong one, and the acceptance of the idea that heat was a form of energy was gradually accepted. Further investigation determined the exact relation of heat to work. These experiments were spread over a number of years, and would occupy too much space to describe them here, but any reader who would like to read a romance might do worse than to get hold of some work on physics which contains the account of the various researches leading up to the final results.

In order to get a clear idea, we will before going any further, define the units of work and heat. Work is the term employed to denote the application of force through a distance, and the unit is a one pound weight lifted through a height of one foot, which is termed one foot pound. One pound lifted two feet high would be two foot pounds. Two pounds lifted one foot high would be two foot pounds. Thus the force on a piston 10 square inches area, and a stroke of one foot, with a steam pressure of 100 lbs. per square inch, would be

$10 \times 100 \times 1 = 1000$ foot pounds.

The unit of heat is that quantity of heat required to raise one pound of water when at its maximum density through one degree on the Fahrenheit scale. The density of water is at a maximum when it is at a temperature of 39.1 degrees Fahrenheit, and above and below that temperature there is a slight change in the quantity of heat required to raise it one degree. We will allude to this again later, when dealing with specific heat.

The quantity of work required to be performed in order to generate the same amount of heat is 778 foot pounds. The unit of heat is called the British Thermal Unit, and the equivalent amount of work is 778 foot pounds.

The time required to raise one pound of water one degree, or the time required to perform 778 foot pounds of work does not affect the quantity. Thus we may take one hour to raise one pound one foot high, and the work would still be one foot pound. We might raise the one pound one foot high by moving it up an inclined plane ten feet in length, but the amount of work performed when we had reached the top would still be only one foot pound.

When we take into account the rate of

doing work we use another unit called the horse power. This is the unit which denotes the doing of 33,000 foot pounds in one minute. Thus if we raise 33,000 pounds through a height of one foot in one minute, we have developed one horse power, while if we take one hour to do the work, we have performed work at the rate of 1 60th of a horse power, or 550 foot pounds per minute. It is important to differentiate between work, and the rate of doing work. We have then three important units. The British Thermal Unit, commonly denoted by the letters B. T. U. and denoting the quantity of heat required to raise one pound of water through one degree Fahrenheit at its maximum density. The unit of work, known as the foot pound, and usually written ft. lb., and the horse power, commonly written h. p., which is the performance of work at the rate of 33,000 ft. lbs. per minute.

Specific Heat

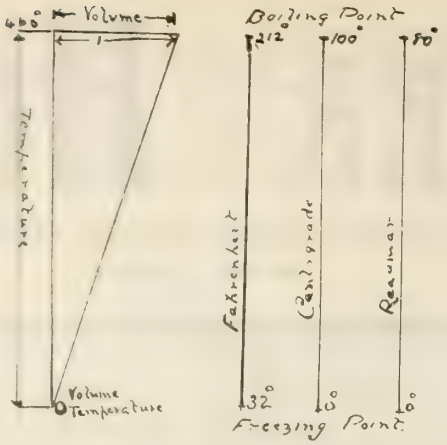
If we denote the amount of heat required to raise water one degree by 1, then the amount of heat to raise any other substance one degree will be a fraction of one, or 1 and a fraction, according to whether the heat required is more or less. For instance, to raise one pound of ice one degree requires only one half a heat unit, so that the specific heat of ice is said to be .5. Thus to raise 10 lbs. of water one degree will require 10 B. T. U., while to raise 10 lbs. of ice 1 degree will only require $10 \times .5$ or 5 B. T. U. The specific heat of water itself is slightly different to 1 when at high temperatures. Thus the quantity of heat required to raise one pound of water one degree when at a temperature of 228 degrees, and a pressure of 20 pounds absolute, is 1.008 B. T. U. as against 1 B. T. U. at its maximum density. From this we get the rule that to find the quantity of heat required to raise any substance one degree, we multiply its weight by its specific heat.

Thermometer Scales

We have spoken of water at 39.1 Fahrenheit, as being at its maximum density. We mention Fahrenheit specifically to distinguish it from the other scales which are in use. There are two thermometer scales which are important to know, and a third which is used very occasionally. They are all different in their divisions, and it is necessary to know how to convert readings from one to the other.

The Fahrenheit scale has its freezing point fixed at 32 degrees, and its boiling point at 212 degrees. There are thus 180 degrees between freezing and boiling point. The freezing point was originally fixed at 32, due to an erroneous idea that 32 degrees below that point was the absolute zero of temperature. This has since been altered, but the scale has been left in its original state.

The Centigrade thermometer is marked 0 at its freezing point, and 100 at its boiling point there being 100 divisions between freezing and boiling points.



Left diagram showing absolute zero of temperature and volume. Right: The different Thermometer scales.

The third scale, known as the Reaumer, is marked 0 at its freezing point and 80 deg. at boiling point, there being thus 80 degrees between the two. We have then three different scales, having 180, 100, and 80 degrees respectively between freezing and boiling point. The proportion they bear to each other is thus

as 180 : 100 : 80

or as

9 : 5 : 4.

That is, the relation that the reading on Fahrenheit bears to the reading on Centigrade is 9 to 5, and to Reaumur 9 to 4. This is not a direct proportion, as a correction has to be made on account of the different position of the freezing point on Fahrenheit as compared to the other two scales.

Suppose the Fahrenheit scale stands at its boiling point 212. We wish to find the corresponding points on Centigrade and Reaumur.

We must first subtract from the Fahrenheit scale the 32 degrees which represents the amount that the freezing point on F. is above zero and then use the proportion. We then have

$$212 - 32 = 180$$

and as the proportion is 9 to 5, Centigrade will be 5/9ths of 180. The expression is

$$(212 - 32) \times \frac{5}{9} = 100$$

If it is Reaumur the proportion is 9 to 4 so we multiply by 4/9

$$(212 - 32) \times \frac{4}{9} = 80$$

It will thus be noted that the procedure is to first subtract the 32 from the Fahrenheit reading before applying the proportion, when the conversion is from Fahrenheit to either of the others. This is important.

In the reverse proceeding, that is converting Centigrade or Reaumur to Fahrenheit, we perform the proportion first and then add the 32.

Thus if the Centigrade thermometer is at 100 the Fahrenheit will be

$$100 \times \frac{9}{5} + 32 = 212$$

while the Reaumur would be

$$80 \times \frac{9}{4} + 32 = 212$$

If it is borne in mind that in converting F. to C. or R. the subtraction of 32 is performed before the multiplication, and in converting to F. from either of the others the multiplication is done first and the addition last.

Absolute Zero

We spoke a little while ago, about the absolute zero of temperature. This is a theoretical conception of a point where neither temperature nor volume exists, and is therefore rightly described as an absolute zero. It is a datum line for making calculations in thermo dynamics, and was determined as follows: It was found that in increasing the temperature of air, a definite increase of its volume occurred for each degree increase of temperature, and this increase was the same at all temperatures. The increase of volume per degree temperature Fahrenheit was found by experiment to be 1/460th, or to be exact 1/459.5. This being the case, assuming that the volume decreased by the same amount for each degree the temperature was decreased, a point would be reached where neither temperature or volume would exist. If the freezing point is taken as a starting point, then at 492 degrees below 32, or 460 degrees below zero Fahrenheit we should come to the absolute zero. Absolute temperature is denoted in formulas by the capital T.

On the Centigrade scale the absolute zero is of course different, by reason of the different divisions. The increase of volume per degree Centigrade is 1/273-rd, and thus we find the absolute zero would be at 273 degrees below zero Centigrade. These are the two quantities used in all calculation on volumes of gases.

Latent and Sensible Heat

Heat is not always presented in a form that can be seen or felt, although its effects may be quite apparent, as is the case with the electric current. Heat which causes an alteration in the reading of a thermometer scale, or can be felt by the body, making itself apparent to the senses is called sensible heat. The reason is obvious. A considerable quantity of heat may be absorbed without any difference being apparent on the thermometer, the effect being noticeable by a change of state in the body absorbing the heat. This kind of heat is therefore called latent heat. Latent heat is a most important factor in the application of heat to the development of power, in an engine, and is equally as important in the application of the principles of heat to the production of cold. It may sound

peculiar to the beginner when we state that we need to produce cold, but we will be able shortly to make this seeming paradox quite understandable to him.

In order for water to be turned into steam, or ice to be turned into water, a certain amount of heat must be absorbed, which will have no effect on the temperature of the water or ice. In order to condense steam into water, or to change water into ice, a corresponding amount of heat will be given up to surrounding atmosphere or other medium, without any effect being noticed on the thermometer. This heat is the latent heat. If we take a piece of ice weighing one pound, at a temperature of 32 degrees, and wish to obtain one pound of water at 32 degrees, we must apply heat to make the change. This quantity of heat would be absorbed by the ice, and would be present in the water, but the temperature before melting and the temperature after melting would be identical, 32 degrees. We know from experiments and research just what this amount of heat will be, and in the case of ice it is 144 B. T. U. In the same way to turn one pound of water at atmospheric pressure into steam at the same pressure the amount of latent heat required is 966.6 B. T. U., which is absorbed by the water, and is present in the steam, in addition to the quantity of heat added to bring the water from 32 degrees to 212, which is 180 B. T. U.

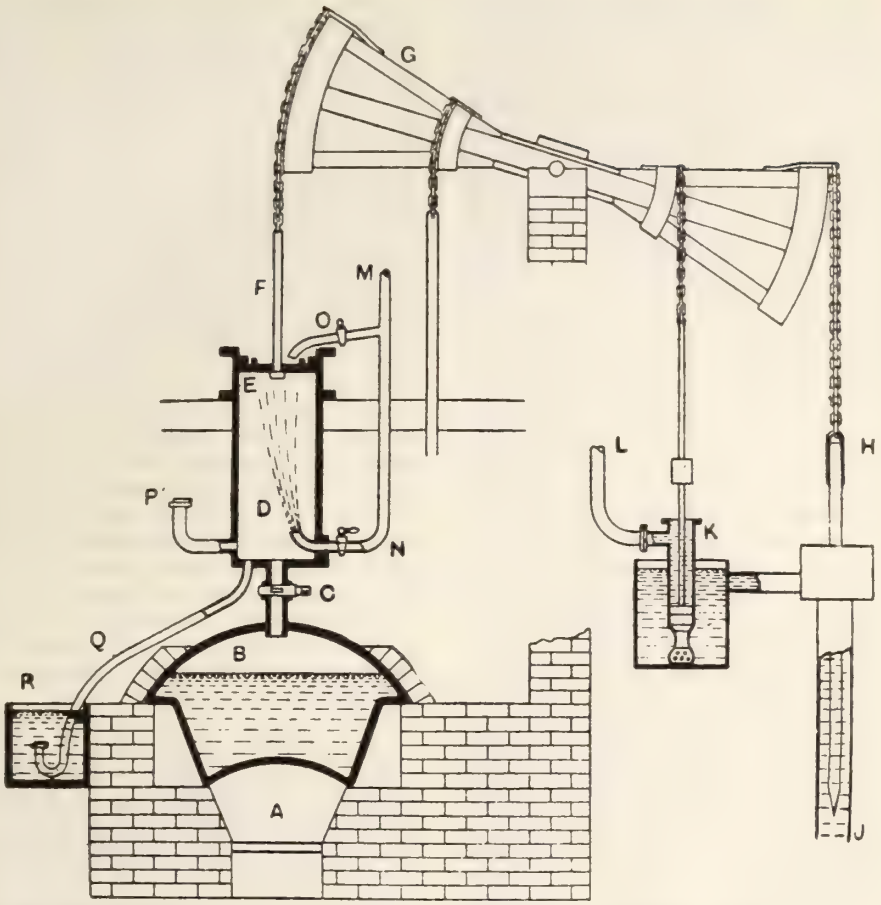
The total heat of steam is then the sum of the latent heat and sensible heat and the total amount of energy available in the steam is the product of the total heat by its work equivalent, or B. T. U.'s x 778. Now if we wish to condense this steam back to water at 212 degrees, we have to use some means to carry away the latent heat. Now in order to transfer heat from one body to another, the body which is going to take up the heat must be at a lower temperature than the body which is going to give up the heat, as the transfer of heat always occurs from a hot body to a cooler one, and cannot possibly take place in the other direction. In order to condense the steam then we usually use water at a much lower temperature than the steam, and raise the temperature of the water. Thus if we have available water at a temperature of 60 degrees, and wish to condense our pound of steam we shall have to use a quantity of water depending on the amount the temperature of the water is to be raised. Suppose we are going to have an increase of 20 degrees in the temperature of the water, that is 20 B. T. U. per pound of water used. As we have 966.6 B. T. U. to carry away, we shall need 966.6/20 or 48.3 lbs. of water required to remove the latent heat from the steam and change it back to water again.

Radiation, Conduction, and Convection

Having obtained a fundamental idea of the nature of heat, we can now enquire into the manner in which this heat is transferred from one body to another. There are three distinct ways in which this heat transference takes place, first by radiation, second by conduction, and third by convection. A hot body radiates heat in straight lines through the atmosphere, part of it being absorbed on the way, its intensity varying with the square of the distance from the radiating body. Suppose we have a hot body in the centre of a space. The intensity of the heat at a distance of one foot may be taken as 1. Then at a distance of two feet it will be divided by the square of 2, at four feet divided by the square of 4. That is at 2 feet the intensity will be ¼, and at 4 feet 1/16th of the intensity at 1 foot.

The heat from the burning coal in a boiler furnace is radiated to the heating surface of the boiler. It passes through the plate by conduction. Different metals have different powers of conduction. Copper is among the best, while lead is one of the worst. Taking silver as 100, copper has a conductivity of 74 and lead 8.5. Iron and steel are about the same, 11.9 and 11.6 respectively. Water is a very bad conductor of heat, but is a good conveyor. Convection of heat is literally the carrying of heat from one place to another by a current, such as a current of water or a current of air. The water in a boiler is heated by convection, after the heat has been conducted through the plates to the water. The water immediately in contact with the heated plate becomes lighter with the increase in temperature, and rises, cooler water taking its place, and in turn becoming heated and rising. The heat is thus gradually carried all through the water in the boiler by convection.

Heat is again lost by conduction through the plates of the boiler to the surrounding air, and radiated away. Hence the necessity of good insulation.



A The boiler furnace.
B The steam boiler.
C The steam valve.
D The engine cylinder.
E The piston.
F The piston rod.
G The main beam.
H The heavy pump rod.
J The mine pump.
K The pump for condensing water.
L Condenser pipe.
M Condensing water pipe.
N Injection cock to cylinder.
O Water tap on top of piston.
P Relief valve.
Q Eduction pipe with non return valve.
R Feed water tank.

Application of Heat to Work

We know that heat is interchangeable with work, but we have not yet seen how this interchange can take place. We said that in the case of the pound of water changed into steam, that it contained after the change the latent heat necessary to make the change, and the sensible heat which raised the temperature from the melting point of ice to the boiling point of water. The melting point of ice, is always taken as the basis for the calculation of the quantity of heat available. We have then in one

pound of water at atmospheric pressure 212—32, plus 966.6 heat units. That is 1,146.6 B. T. U. and this is equivalent to 892,054.8 ft. lbs. Now if we could use all this energy contained in that pound of steam in one minute, we should have 27 horse power. Unfortunately we cannot do this, and the amount that we can use is a very small fraction of the total. In fact the only way in which we could usefully employ this steam to develop power would be to deliver it to the blades of a turbine which was operating under very low back pressure, that is a pressure considerably below that of the atmosphere. We could use it very well for heating. In order for it to perform work, we must have different conditions. The first application of the heat in steam to developing power in an engine was Newcomen's pumping engine, and a brief description of its action here will be of service to the reader. Later on he will see a certain likeness between the processes in a refrigerating machine and those in Newcomen's engine. The illustration shows the general arrangement of the apparatus.

Suppose the piston at the top of its stroke, and the under side filled with steam at atmospheric pressure, which was all that was carried on this engine. There is then atmospheric pressure on top of the piston, and also underneath it, maintaining a state of equilibrium. The heavy pump rod and pump are at the bottom of their stroke. At this point a jet of water is introduced from the tank to the cylinder, condensing the steam therein. Now steam at atmospheric pressure occupies about 1,600 times the volume of the water it is formed from, and conversely the water will only occupy 1/1600th approximately of the space occupied by the steam. The result of the steam under this piston being condensed is then to lower the pressure considerably below that of the atmosphere, or in other words, to form a partial vacuum. The equilibrium of the piston no longer exists, and the pressure of the atmosphere forces the piston down, pulling the pump rod up. In order that the pump rod may again descend, it is necessary to again equalize the pressure on each side of the piston, which is done by opening the valve between boiler and cylinder and again filling the cylinder with steam at atmospheric pressure. The weight of the pump rod then over-balances the weight of the piston and beam, and the piston goes to the top of the cylinder, the pump descending to the bottom of its stroke.

Although at first it may be hard to see just how the heat in the steam performs work in this case, yet a little examination will make it clear. The work done by the atmosphere on the piston is equal to the difference in weight between the piston, rod, and half the beam, and the weight of the pump rod, pump, and half the beam, plus the weight of the water multiplied by the height lifted. Now we have obtained this work by creating a difference of pressure between the two sides of the piston, and in order to obtain that difference of pressure we have been compelled to dissipate the heat. In this case, we have given it up to the water from the condenser tank, which is injected into the space under the piston. Now if instead of utilizing the difference in volume between steam and its condensate, we might have achieved the same object by exhausting the air from under the piston by means of a pump, we should have had to apply power to the piston of the pump in some form, and the work done would be equal to the mean effective pressure against which the air pump worked by the displacement of the piston while emptying the cylinder of the engine. This work would be the equivalent of the power applied to the pump, and this power would have a definite heat equivalent. In the Newcomen engine, the heat applied to the water in the boiler appears in the steam, and is then given up to the water injected into the cylinder, changing the steam back into water.

Heat is Not Lost

It will be noticed that in all these operations, the heat appears in one form or another, but at any stage of the cycle, there is always the same amount of heat present. We take a certain amount of coal and place it on the grate of a boiler. We say that it has a certain heat value. We mean by this that in the disassociation of its various constituents during the process of rapid combustion, in conjunction with the oxygen of the air, heat will be evolved. This heat is the equivalent of the heat that has been absorbed by the coal through long centuries of change from the original tree. The heat given up by the coal reappears in the water in the boiler, though not all of it. Some has gone to heat the brick setting, and radiated off to the atmosphere, but if we had sufficiently delicate instruments we would find that the increase of temperature in the boiler metal, the water, the setting, and the atmosphere surrounding it would just be equal to the heat given up by the combustion of the coal. We carry the heat in the form of steam from the boiler to the engine, where some more heat is given up to the surroundings on the way. The steam is applied to the piston of an engine, driving it forward, and in doing so giving up heat. The exact equivalent of this heat is present in the form of work which has been done on the piston, and in overcoming the friction of bearings. We still have a considerable amount of heat in the steam, when the piston has reached the end of its stroke, and in many cases this steam is ejected to the atmosphere. By just the amount of heat remaining in the steam the atmosphere will be raised in temperature, but owing to the tiny quantity of steam compared to illimitable amount of atmosphere this cannot be noticed. This increase of heat in the atmosphere at the expense of the steam causes it to change its state from a vapor back to its original state of water, at atmospheric temperature, which is what we started from. In all these operations there has been nothing lost and nothing gained. The original heat energy of the coal has been changed into different forms, and a certain proportion of it into useful work, but nothing has disappeared.

This is briefly the theory of the conservation of energy, which means that there is a certain amount of energy available in the world, and that this energy is the same today as in the beginning, and always will be. It is never destroyed, it merely changes its form. It cannot be created. We can change heat into work, or generate heat by the performance of work, but we cannot create either. By changing one into the other we can during the process apply a certain amount of the heat to useful work, but we can never get the exact equivalent of the heat in the form of work. A certain amount is lost in overcoming friction, either mechanical or chemical, and although we can bring this down to very fine limits, we can never hope to eliminate it.

This is expressed in the second law of thermo dynamics, which is stated in various ways. We will give two of them here. First "No change in a system of bodies that takes place of itself can increase the available energy of a system."

The second is Lord Kelvin's definition, "It is impossible by means of inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of surrounding objects."

These fundamental laws are necessary to the understanding of the student of refrigeration, and he can by their aid grasp the idea of the principles without any deep excursion into the realms of higher mathematics. He must understand clearly the relation between heat and work, and also another point that seems to be a stumbling block to many men, that is the relation between heat and temperature. A piece of ice though cold to the touch possesses heat. It has a certain amount of heat at a low temperature. You may have 1000 B. T. U. present in a body at a temperature of 1 degree, while in another body you may have the same number of B. T. U. present at a temperature of 500 degrees. The same amount of heat would be present in each, but there would be a difference of 499 degrees in their temperature. Probably a good comparison of this would be in the case of the weight and pressure of steam. If you have one pound of steam at atmospheric pressure in one case, and the same weight of steam at 100 lbs. pressure in the second case, you have the same weight of steam in both, but only 1/100 the volume in

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Steam Flow Meters

By E. KIEFT

Engineer of Tests, Gary Works, Illinois Steel Co., in "Combustion."

IT IS with the steam flow meter as it is with the world in general. The world is neither good nor bad; it is what we make of it.

The steam flow meter is one of the most valuable instruments in any power plant and in any manufacturing plant where steam is used to any considerable extent, i. e., the steam flow meter ought to be used on any plant where the production or consumption exceeds 15,000 lbs. of steam per hour. In many smaller plants where steam is widely distributed, it would be a profitable investment to use a steam flow meter of a suitable type for the purpose. There are conditions where a portable steam flow meter will give very satisfactory results and there are also cases where it would be advisable to have a central steam flow meter installed connected electrically with the different steam consumers or producers.

There exist various opinions about the reliability and accuracy of a steam flow meter. It is my experience that a steam flow meter will do the work that it is proposed to do, if those in charge of the installation and operation follow the builder's instructions, using, besides, a little common sense in selecting the proper location for the apparatus.

The principle on which the steam flow meters work is generally a function dependent on the laws of gravity. What is more reliable than gravity? For operation most steam flow meters depend upon the differential pressure obtained by means of pitot tubes, venturi tubes, nozzle tubes or orifice plates. The latter are the most convenient for the purpose, but great care must be taken when making the pipe connections. The most important point to observe is that the meter taps are at the proper distance from the orifice plate; further, the connections leading to the meter body must be absolutely tight, otherwise there is a possible error due to faulty differential indications. All the other devices for getting a differential pressure will give satisfactory results when applied in the proper manner.

Any kind of differential pressure can be obtained for a given quantity of steam by varying the size of the pipe when using pitot tubes or nozzle tubes. The size of a venturi throat governs the differential pressure obtainable with a venturi tube and the size of the orifice of an orifice plate gives also any desirable differential. In most cases we can make a rough estimate of the possible variation of the quantity of steam to be measured so that it is required of the engineer in charge to get a practicable differential pressure suitable for the type of meter he wants to install. Anyone who wishes to install a steam flow meter can get all the necessary information from any of the leading flow meter manufacturers.

There are corrections to be made for the density due to fluctuation of steam pressure, moisture or superheat. These corrections are only necessary for specific conditions such as in boiler tests and scientific investigation work. An average meter factor will answer all general operation requirements.

Statements of some critics that steam flow meters do not help to carry the boiler load are ridiculous. They might as well state that a compass or sextant will not move the ship or that the steam flow meter has not any calorific power. Arguments about the incompetency of firemen and ignorance about the functions of a stack damper are poor excuses which reflect more on the ability of the boiler foreman or power plant engineer than on the steam flow meter.

A standard boiler test code does not recognize the flow meter as a suitable means of measuring the performance of a boiler when efficiency is to be determined, due to the fact that this code has to be a general code, suitable for any engineer in detail, and for any layman in general, in order to suit engineering and commercial requiremets. To my knowledge boiler tests have been made with venturi water meters and steam flow meters. Among these were so-called acceptance tests, giving me just as much confidence in my results as other tests which were made in compliance with the standard test code, i. e., weighing the water. One instance is known of a boiler being credited with about 25 per cent. more steam than it actually made, notwithstanding the fact that the water was weighed. When the water is weighed someone is always needed to put the figures on paper. The mental factor of the man who records, is just as liable to go out of commission as anything else. There are all kinds of leaks occurring for which you can not blame the boiler.

What is the use of an engineering education if we do not apply the theories in practice? If a big concern like the General Electric Company with a world-wide reputation is putting something on the market, you may be confident that it is something more than a mere plaything. The same thing can be said of the other leading flow meter concerns. They all have engineers of high standing.

The leading steel manufacturing plants are generating vast quantities of steam by utilizing waste heat from the open hearth furnaces, surplus blast furnace gas, coke oven gas, coke breeze and all kinds of inferior fuel not suitable for steel manufacture. There are even times that they have a surplus of waste heat and inferior fuel. Steam flow meters have been used in these plants for the past ten years and in many of them there is an increased demand. Even during the prevailing depression times there are some funds allowed for the installation of steam flow meter equipment; this is the most convincing explanation and answer for the question: "Is a steam flow meter a paying investment?" Steel mill executives do not spend money for ornamental equipment —they go by the cost sheets. If a steam flow meter is already a paying investment at a steel mill, how much more will that mean for a plant being dependent on coal only for fulfillment of the steam requirements.

Concerning the financial saving when using steam flow meters, it may be stated that a minimum saving of 5 per cent. in operating cost can be obtained on any plant of more than 15,000 lbs. capacity (this does not include plants that are already equipped with other kinds of scientific instruments such as CO_2 recorders, automatic draft regulators, etc.); further, that at many existing plants there is a possibility of a 10 per cent. or greater saving by installing a steam flow meter. It is understood that the steam flow meter is in the hands of a man who can interpret results; further, that the draft gauge is part of the boiler installation and that the damper of the boiler is not entirely out of commission. The steam flow meter shows you what your conditions are if you apply the results with a little common sense. If you have an installation, let us say of twenty boilers to equip with steam flow meters, the first question is how to get a maximum amount of information with a minimum amount of equipment. This question is answered according to my experience by putting a central steam flow meter in the office of the boiler foreman, if he has any, or otherwise select a spot just as good and connect this central meter electrically with each boiler. Steam flow meter equipments similar to the kind put on the market by the Republic Flow Meter Co. will be very suitable for the purpose. If the money is available, then there is also a justification for a simple indicator on each boiler, provided that this does not involve considerable piping and pipe-fitting. The length of pipe connection between the taps at the unit inserted into the steam line, and the unit which converts the velocity into a differential pressure must be a minimum in order to reduce trouble.

What does the steam flow meter then show?

First: It tells which boilers are out of step or loafing on the line.

Second: It makes you go out on the firing line and look for the little things, such as leaks, settings, improper air distribution under the stokers or grates, the effects of forgetting to keep the soot from the outside of the boiler flues, and the physical meaning of a stack damper.

Third: It will increase the inventive

spirit of the organization of the boiler house—everyone gets more enthusiastic about the performance. That is at least my experience. There are many operators and engineers who have never taken notice of the importance of feeding the boiler in a systematic way. To keep the water always on the same level appears e the best way, but if you hunt up your books and papers on Thermodynamics and sit down, doing a little figuring and sound reasoning, you will find that a boiler can also be used as a steam accumulator by bringing the water up high in the glass during the light load and allow the water to go down to the bottom of the glass during the peak loads. You will find that there exist certain connections which permit of the sudden inrush of feed water, as some automatic regulators permit when the load comes on, and are thus more responsible for sudden drops in pressure than the peak load proper. Right there is something for the progressive operator or engineer to look into.

Fourth: In case of waste heat installations, you may find that your boiler does mighty well on a certain day. You feel proud about that boiler, and go out in the field to study the special features of this boiler and its environment. Gas analysis, temperatures, and pressures are taken all the way from the open hearth or any other furnace to the stack, and before you are through you have found from your analysis that vast quantities of the principal fuel are bypassing through a leaky valve. One discovery of this kind pays for the whole installation. Some other day you find the steam flow meter on some other boiler reading quite low. Again you go out exploring and you may find waste gases, air and water at their afternoon party, meeting in the flues before they enter the boiler, causing low entering temperatures and consequently low steam output. Somebody may ask: "Can you not find out these things without a steam flow meter?" Certainly you can, but the steam flow meter is a great help. The above statements are not stories—they are a few of the many facts observed during years of personal experience with steam power, electric power and many branches of metallurgical engineering.

HORSE POWER CHART

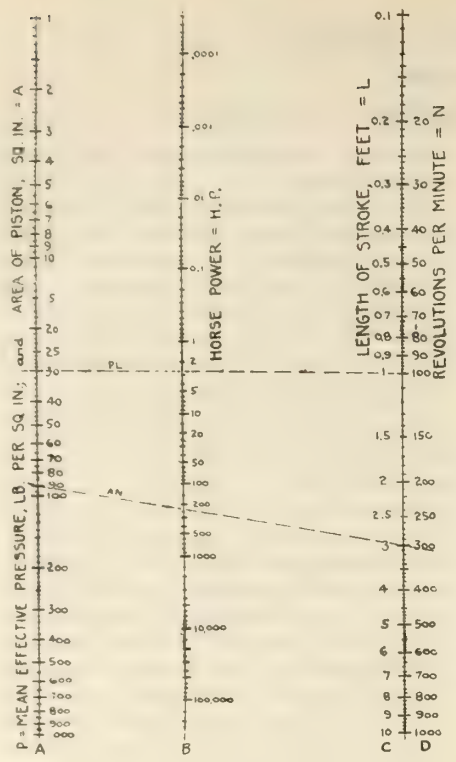
By W. F. Schaphorst

This solves the much-used formula

$$\text{Horse Power} = \frac{\text{PLAN}}{33{,}000}$$

For example, what is the horse power of the crank end of a steam engine, the mean effective pressure being 30 pounds per sq. in.; the piston area being 90 square inches; the length of strokes one foot; and the number of revolutions being 300 per minute?

Connect the 30 (Column A) with the



1 (Column C) and locate the intersection with Column B. Then connect the 90 (Column A) with the 300 (Column D) and locate the second intersection with Column B. Now locate the mid-point between the intersections in Column B. It is a simple matter to find the mid-point by folding a piece of marked paper, by means of a pair of dividers, by measuring with a rule, or any other easy way of bisecting a line.

The mid-point, Column B, gives the horse power of the crank end as being very close to 25 h.p. Multiply it out "longhand" and you will find the exact power as given by the formula to be 24.5 h. p.

The chart will therefore prove itself to be highly useful in checking over your figures, in case you are desirous of being absolutely sure of your computations. Generally, it will be found close enough for most practical purposes.

It will be noted that the range of the chart is very great indeed—running up to over 100,000 h. p.—thus including every steam engine ever built. The lowest range is 1/10,000 of a h.p., which would be a most delicate toy engine.

A USEFUL EXPANSION CHART

By N. G. Near

Machinists will find this chart useful for determining the expansion to be allowed in piping rods, tubes, etc., for various temperature differences without doing any "longhand figuring" whatsoever.

To use the chart simply lay a straightedge across it once, or stretch a fine black thread across it, as indicated by the dotted line, and the problem is solved without further ado.

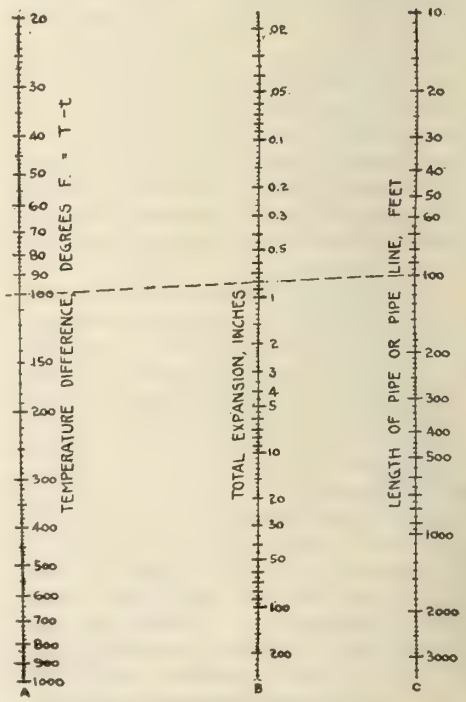
For example, a certain pipe line is installed which is 100 ft. long. It will be subjected to a temperature variation of 100 degrees F. What will be the total expansion in inches?

Connect the 100 degrees temperature difference, Column A, with the 100 ft. length, Column C. The intersection with Column B gives the answer as 0.8 inch. That's all there is to it. Very simple indeed.

Inversely the chart can be used for determining the allowable temperature difference where a definite amount of space is available for expansion and contraction. Thus if the length of the pipe line is 100 ft. and the allowable expansion is 0.8 inch the same line would show that a temperature difference of 100 degrees F. would be the limiting amount.

Also, if the factors in Columns A and B are known, the unknown in Column C is immediately found. In other words, if any two of the factors are known the third factor is very quickly found, and without any computing whatever.

It will be noted that the range of the chart is wide enough to take care of almost any expansion or contraction problem that the machinist may have to contend with. The temperature difference, Column A, varies all the way from 20 degrees to 1000 degrees. It is very seldom, if ever, that we have as high an amount as 1000 degrees. The length of pipe line, also, is great, varying all the way from 10 ft. to 3000 ft., or more than a half of a mile. And the total expansion between these limits varies all the way from 0.02 inch to 200 inches. It is interesting to note that if we had a pipe line 3000 ft. long, with a temperature difference of 1000 degrees, the expansion would be over 200 inches.



Generating Steam By Electricity

Under Certain Conditions it is Possible to Use Electric Power for Steam Generation Purposes. It is Being Done in Some Canadian Plants To-day, and Has Been Used in Europe for Some Years

WHILE there has been in European countries, a considerable use of electric steam generators, the principle has not been very widely used in Canada, or the United States. There are some installations that have been operating for a short time in this country, and these installations together with a description of the general principle were described by Mr. F. T. Kaelin, Chief Engineer of the Shawinigan Water & Power Co., at a recent meeting of the Engineering Institute of Canada.

Advantages

Under prevailing conditions where electric power is sold on a kilowatt hour basis, electric steam generation cannot compete with steam produced by fuel, but it is not beyond the possibility that in some remote places where the cost of fuel and freight are high and the cost of a hydro electric development is low, the electric steam generator with its very low capital investment and operating expenses may become a competitor to the method of generating steam by burning coal or oil, but it is not necessary to consider such an exceptional case to prove that the generator fills well its place permanently as a transformer of idle power into useful heat energy. We may consider its usefulness mainly from two different points of view:

Consumers

1. From the point of view of the consumer of electric power owning a hydro electric installation, or purchasing blocks of firm hydro electric power on a flat rate power contract and using this power for manufacturing purposes only, during a smaller part of the twenty-four hours. In many manufacturing plants steam has to be produced for cooking processes, drying, humidifying, and in all cases heat is required for heating purposes during six months and during the full twenty-four hours. Here we have electric power lying for twenty-four hours and paid for. The thought comes to us, what can be done with this idle power? Is there any cheap way of transforming this electric power into something useful? It is well known that electric energy can be transformed into heat energy at a very high efficiency. One of the cheapest ways of doing this is to produce steam which in most cases can be used in conjunction with other steam generating apparatus, and where a system of piping for the purpose of heating or using steam for manufacturing purposes already exists.

The low cost of the steam generator compared with other electrical apparatus for the conversion of electric energy into heat, and the wiring and control apparatus necessary for such equipment, is very much in favor of the steam generator. It can be shown that even in extreme cases where the load factor is comparatively high, for instance in pulp and paper manufacturing plants using a considerable amount of power during six days of the week and having it idle for the seventh day and at the prevailing cost of hydro electric power purchased in big blocks by these companies that it is economically quite feasible to turn the power which was used during six days, mainly for pulp grinding, during the seventh day into steam which is always required in such places, either for manufacturing or heating purposes. It was shown in an investigation made lately that the saving of coal during the fifty-two Sundays and three holidays would easily pay for the installation of the steam generator in less than one year, and there are no doubt quite a number of pulp and paper plants in this country where similar conditions exist and where a considerable saving could be accomplished.

Power Producing Companies

2. From the point of view of the Power Company producing and selling hydro electric power, the present commercial depression and slowing up of the industrial activities have left hydro electric companies with surplus of power for disposal. How long this condition is going to last is uncertain but there is no doubt that a considerable amount of unused power will be available for the next two or three years. Power companies can afford to sell this power at cheaper rates during such time as there is no other market for the power, though preferably under conditions which allow the power company to cancel the contracts on short notice. But at the same time it must be clearly understood that no power company could afford to develop hydro electric power for the main purpose of generating steam electrically in competition with coal.

The problem has been to find a use for this idle power which would not require any expensive installation, new machinery or additional apparatus, for instance, transformers, etc., and as it was out of the question to use the power, for new industries or the manufacture of new products which require considerable power like those produced in the electro-chemical industry, one of the solutions was to turn the electric power into heat in the form of steam which is used to a very great extent in many industries, especially in the pulp and paper industry. To do this, of course, other factors have to be favorable such as the transmission of the power, the proper voltage available that would not mean any further transformation and the low cost of the whole installation for generating steam electrically.

Although some of these installations which are in operation to-day may be considered as quite temporary due to the prevailing exceptional conditions, there is no doubt that in many cases the electric steam generator is going to stay and be used at such times as there is power available from the power companies. This is usually the case during three or four summer months when the water-flow in the river is high and a certain amount of surplus power is available. It may even be feasible to use only night power by close co-operation of the power company with the power user, and the fact that starting and stopping electric steam generators takes only a few minutes. These are all points which make the steam generator a very flexible apparatus and make it very useful to convert electric energy at any time at short notice and at extremely low cost to valuable heat energy.

Efficiency

In the electric steam generator all electric energy is converted into heat energy, the electric current passes through a resistance either of metal or formed by the water to be evaporated. The whole process of conversion is therefore governed by ohmic law. 1 k. w. h. is equivalent to 3,412 B. t. u., the total heat content of 1 lb. of steam at an absolute pressure of 150 lbs. per square inch is 1,139 B. t. u. Assuming feed water temperature of 150° F. the total heat to be supplied will be 1.139—(150-32) = 1,075 B. t. u. 1 K. W. H. will therefore produce

$$\frac{3412}{1075} = 3.17 \text{ lbs. of}$$

steam, no heat loss considered.

The efficiency of the electric steam generator is very high, the only losses are the radiation losses of the apparatus, and the heat losses represented by a certain amount of water discharged from the generator which carries away a certain amount of accumulated impurities in the feed water. By proper lagging and regulation of this discharge water the losses become very small and depending on the size of the generator may be from 1 to 4%—for larger sizes of generators the efficiency can be

taken around 98%. On this basis 1 k. w. h. will produce 3.10 lbs. steam. Under average conditions 1 lb. of soft coal of about 12,000 B. t. u. evaporates about 8 lbs. of water. 1 ton of 2,000 lbs. of coal evaporates 16,000 lbs. of water. The electric energy required to evaporate the same amount of water is equal to

$$\frac{16{,}000}{3.10} = 5{,}161 \text{ KWH.} = 215 \text{ KW}$$

days = .59 k. w. years = .8 h. p. year, or in other words 215 k. w. in an electric steam generator is equal to one ton of coal per day, burned under average conditions of boiler efficiency.

Comparing the capacity of an electric steam generator with the capacity of a regular boiler in boiler horse-power, we find the following relations: One boiler horsepower is defined equivalent as the evaporation of 34½ lbs. of water from and at 212° F. per hour and represents 33,479 H. t. u. per hour, 1 k. w. hour being 3,412 H. t. u. and at an average efficiency of 98% equal to 3,342. These figures are almost exactly in the ratio of 10 to 1, therefore, an electric steam generator of 1,000 k. w. capacity is equal to a boiler of 100 boiler horsepower.

Classes of Electric Steam Generators

Electric steam generators have been built during the last ten years in capacities up to 1,000 k. w., and only in the last two sizes of 2,000 k. w. and more have made their appearance. Steam generators may be divided into two main and distinct classes:

First—Generators in which the electric current passes through a combination of metallic resistors.

Second—Generators in which the water itself forms the electric resistance.

Metallic Resistance

In the first case the metallic resistors in the form of wire and ribbon of some high resistance alloy may be mounted in tubes similar to those in fire tube boilers. The arrangements allow the use of alternating or direct current as heating elements do not come in direct contact with water. In all other cases where the resistors are in contact with water and the current passes partly through metallic resistors and partly through water only alternating current can be used as direct current would decompose water into its elements hydrogen and oxygen. Generators of the metallic resistor type are only suitable for low voltages up to about 500 volts and are therefore not usually adaptable for very large outputs. The steam production is controlled by switching on and off of a number of parallel circuits and the combination of such circuits in parallel or series connection. To maintain a constant steam pressure requires, therefore, rather complicated and expensive electric control equipment. Generators of this type have been built of 1,500 k. w. capacity, being of the tubular type construction, about 20 ft. long and 5 ft. 6 inches in diameter. The space occupied by this type of generator is comparatively large compared with the steam generating capacity.

Water Resistance Type

The second class of generators which will be mainly dealt with in this paper are built on a principle quite different from the metallic resistor units. The electric current passes through steam tight insulating bushings to a system of stationary electrodes partly submerged in water, the water to be evaporated serves as the electric resistance. This type of generator is known as the "Revel Generator" and has been in use principally in Italy, Switzerland and France for the last ten years, mostly in self-contained units up to about 700 k.w. For any considerable amount of electric power only a three phase alternating current system may be considered as practical to-day. For small units and of voltages up to about 2,200 volts, the container itself forms the neutral point of the three phase system and is grounded. For larger capacity generators, especially when the voltage is in excess of 2,200 volts up to 12,000 volts, it will be advisable to split up the generator into three single phase units with three containers, each containing one electrode, the three containers form again the neutral point and are metallically connected together and grounded. Owing to the comparatively high resistance of the water and the many possibilities of arranging the electrodes, it is possible to make use of comparatively high voltages such as are used in general distribution of power in industrial plants, and the use of step-down transformers, the cost of which would be greater than the cost of the steam generator itself is obviated. In order to maintain a constant steam pressure the generation of the steam has to follow closely the demand of the steam which means the electric power input has to be regulated to suit the steam demand. This is done by the variation of the electric resistance, either by changing the submersion of the electrodes, or varying the specific resistance of the water by suitably adjusting the amount of water fed to the generator and by controlling the water discharged either continuously or at certain intervals, carrying with it the accumulated impurities in the water.

The outstanding advantages of the steam generator of the water resistance type compared with other types are its simplicity in construction, compactness, easy control, and its very low cost per kilowatt capacity which is very often the determining factor, especially for temporary installations or where flat rate power is consumed to fatten the load factor of an industrial plant.

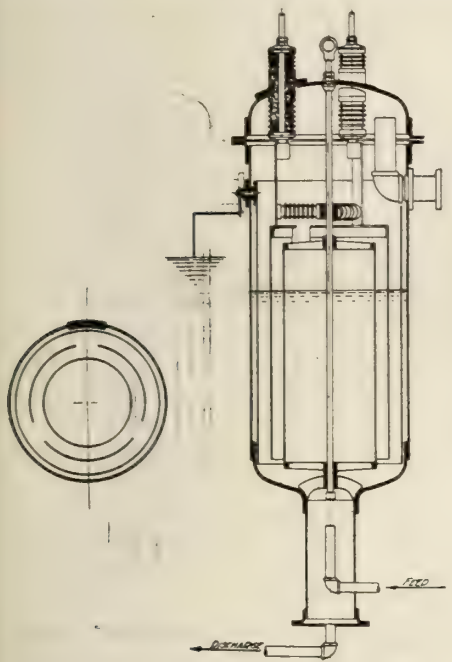
Construction Details of Water Resistance Type of Generator

The balance of this paper will deal only with generators of the water-resistance type. For a long time water has been used as a resistor of alternating current in various apparatus, mainly as energy absorber for electric generators under test and in starting devices for alternating current motors. In the latter case a salt is added to the water as otherwise the resistance would be too high. The use of water itself as an electric resistor for the production of steam is quite obvious though it requires a certain amount of investigation as to the suitability of different sources of water, the variations of the resistance of water at various temperatures and pressure and the practical limits in dimensioning the current path through water for various amounts of energy and voltages up to 12,000 volts. The resistance of chemically pure water is very high and of the order of an insulator, the resistance decreases with the contents of soluble salts—it is lower for spring water than river water. Condensate water, available in most cases where the electric steam generator is in use, is of a high resistance, but as it contains always from 20 per cent. to 40 per cent. make up water drawn from the river or other sources its conductivity is brought up again to quite a practical figure. In general, it can be said, that any water satisfactory for ordinary boilers is also suitable for the electric steam generator. The resistance of water has a negative temperature coefficient; that is, the resistance is decreasing as the temperature and the pressure rise. Considerable investigations and tests have been made by the writer to determine the relations of resistance and temperature for various kinds of water, and special apparatus has been built for this purpose for currents up to 10 amperes and 6,000 volts for tests under atmospheric pressure.

In the early stages of the development of the steam generator it was thought that the investigation of the relation of temperature and resistance of different kinds of water would be of great importance but it has been found later by experience in the operation of the steam generator that the resistance of the water in the steam generator could be controlled over a considerable range by discharging a certain amount of water from the generator. The purer the water and the higher the resistance the less water is to be discharged in order to maintain a suitable conductivity of the water.

Fig. 3 shows a section of a 5,000 k.w. generator, it consists of a vertical cylindrical tank with an extension at the bottom. The upper part is flanged and to it is bolted a dished cover which contains three openings for the porcelain bushings insulating the three copper conductors leading to the electrodes. The insulator bushing consists of three parts, two corrugated sleeves, one of which is outside and the other inside the tank and a tube inside these sleeves

which are held together by a shoulder and nut of the conductor passing through them. The faces of the sleeves are ground and are parallel and are made steam tight with the usual rubber steam packing. The packing also allows



Electric Steam Generator 3 phase single unit system.

a certain adjustment for the difference in the expansion of porcelain and copper. The porcelain sleeves are subjected to considerable pressure and are made rather heavy for mechanical reasons and with electrical characteristics suitable for at least 6,600 volts working pressure between the phases. The conductors support through a system of adjustable links the steel electrodes of curved plates arranged in a circle equidistant from two cylinders, one outside and one inside, forming the neutral point of the 3 phase system, the outside fastened to the generator shell proper and the inside suspended from the cover and well secured in a central position. Both these cylinders are electrically connected to the body of the generator and grounded. The arrangement shown in Fig. 3 is for 1,300 amperes, 2.200 volts, 3 phase, 60 cycles and for a working pressure of 165 lbs. per square inch. The electric current passes through from both sides of the electrode to the inside and outside cylinders, and to a much smaller amount directly from electrode to electrode.

Floor Space and Operating Details

The floor space required by these types of generators is very small, the 5,000 k. w. generator with electric control apparatus can easily be placed in an area of 10 x 12 ft., and the 18,000 k.w. generator, equal to 1,800 boiler h. p., with all its accessories will need a floor space of about 15 x 22 ft., and a head-room for easily dismantling of 25 ft.

The operation is extremely simple for the small generator and where they are not working in parallel with other steam plants, the operating can be made automatic by means of a regulating valve actuated by the pressure and controlling the amount of discharge water, thereby changing the water level, which, in turn, governs the power input and steam production and at the same time keeps the steam pressure constant. For large units and especially where they form only a smaller part of the existing steam plant and are therefore, not able to control the pressure alone, automatic regulation is not so simple, but the attention required is so small that one man could easily handle the operation of two to three very large units. For the electric control of the steam generator the usual apparatus such as disconnecting switches, oil switches, and preferably three ammeters to show the balance in the three phase, is required. Power measuring instruments may be added, depending on the nature of the power contract and supply.

As the heat in the steam generator is produced in the water there are no parts subjected to a higher temperature than the temperature of the steam. This means that no dangerous stresses are produced by temperature differences and this adds further to the safety of the apparatus.

There are other advantages of the electric steam generator over the usual coal fired boiler, for instance any interruptions to feed water supply simply means the shutting down of the generator and does not introduce any danger. The steam generator is equipped with the usual steam safety valves and can in addition be supplied with automatic blow-off valve which discharges the water and thereby shuts down the generator should the pressure go beyond a fixed limit. Other safety devices consist in relay protection of the electric circuit in case of short circuit, unbalancing or ground on the electric system, and a trip for the automatic oil switch, which will interrupt power and therefore the steam supply. It can be seen therefore that the operation of the steam generator is just as safe as, if not safer than the ordinary boiler and the insurance companies have no hesitation in accepting insurance on this apparatus in the usual manner.

Conclusions

1. The generator of the water resistance type is safe and easily controlled.
2. The apparatus can be installed in a very small space close to where the steam is required. Its design and operation are very simple and only needs the attention of an ordinary skilled man.
3. The generator is the cheapest electric method of converting electric energy into heat.
4. For the consumer of power the generator means the utilization of any idle power and thereby the improvement of the load factor.
5. The power company is able to sell its surplus power for the generation of steam which is made possible mainly by the fact that the first cost and installation of the steam generator is comparatively low.
6. By the introduction of such a simple and cheap device much idle electric power can be utilized, which in itself means a further step in the conservation of our natural resources.

REFRIGERATION TALKS IN PLAIN LANGUAGE

Continued from page 21

the second case that you have in the first. A better illustration can be found in the case of watts, in the electrical measurement. If you have 100 amperes at 100 volts, you have 10,000 watts. If you have again 10 amperes at 1,000 volts, you still have 10,000 watts, while if you have 1,000 amperes at 10 volts, the number of watts has not been altered. You have a small current flow at a high pressure, or a high current flow at a low pressure, the resulting power being the same.

It is the same with heat and temperature. You can have a large quantity of heat at a very low temperature, and the same amount of heat but at a high temperature level, but in order to obtain work, we must have a drop from a high temperature to a lower one. We cannot obtain work by going from a low to a high temperature level. In order to do this we must perform work. If these points are borne in mind we have the way clear to study their application in the art of refrigeration by mechanical means.

OTTAWA LODGE C. A. S. E.

Ottawa Lodge No. 6, C. A. S. E., held another open meeting on Wednesday evening March 22nd. Mr. Arthur G. Pedder, A. M. E. I. C., assistant chief engineer of the Ottawa Electric Co., gave the members and visitors a treat, demonstrating by aid of lantern slides the inner workings of the steam turbine, using over fifty slides.

He specially explained and dealt with blades, nozzles, governors, lubrication and operation of the steam turbine.

There were a large number of members and visitors present, who enjoyed very much the plain, simple, and instructive manner with which he explained his subject.

Mr. Pedder, who has had a very wide practical experience with large turbine plants, feels very much at home with his subject, and Ottawa Lodge very much appreciate his membership.

Steam Consumption of Soot Blowers

Some Interesting Charts Have Been Produced From Data Obtained at a Large Power Plant. This is the First Time This Information Has Been Made Available

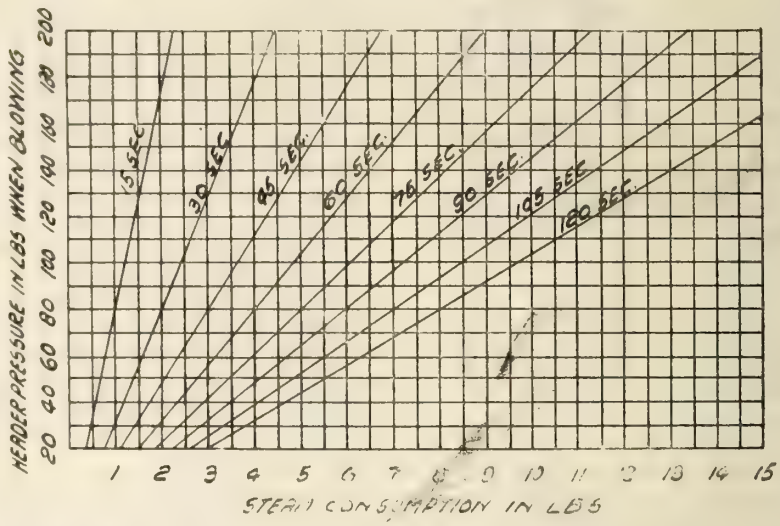
By ROBERT JUNE

ONE OF the outstanding features of the new valve-in-head type of soot blower is the steam saving effected, the unit valve being open just long enough to have the jets pass over the part of the tubes to be cleaned. With the cam adjusted to hold the valve open for 300 deg. the head uses steam from five to seven seconds per revolution. As the gear reduction assures turning of the element slowly and steadily, it is rarely necessary to revolve the blower more than two or three times. This means that steam is being used from fifteen to twenty-one seconds per unit per blowing.

In contrast the valve of the plain revolving soot blower is necessarily open from 45 to 75 seconds, 60 seconds being the average time required for close attentive operation.

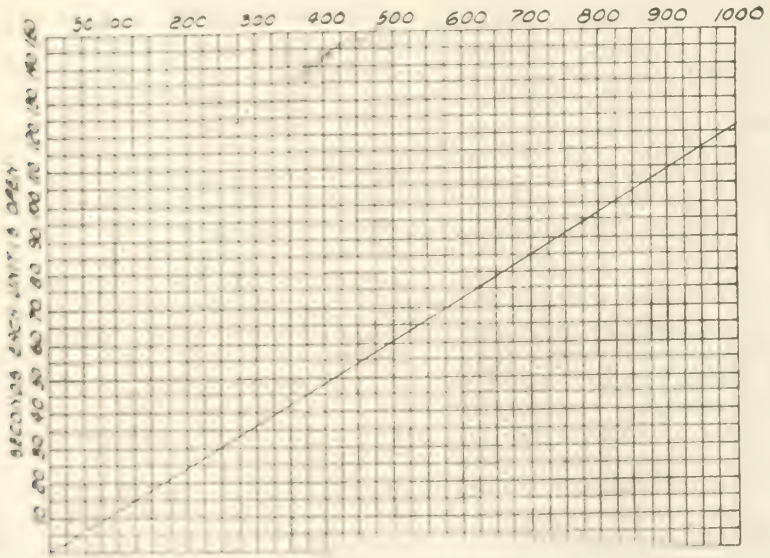
At this point it is well to observe that very few men operating soot blowers realize the importance of giving proper attention to the steam loss due to unit valves being kept open longer than necessary to clean the boiler properly. We have timed a large number of soot blower operations, many of them without the knowledge of the operator, and it has been surprising to note the frequency with which the unit valves are kept open two and three minutes and even longer, while keeping the valves open from a minute and a half to two minutes is common practice.

Fig. 2 is a chart from which the steam loss from excessive blowing can readily be computed. The vertical column of figures at the left is the steam pressure in the header when blowing, while the figures at the bottom show the amount of steam that will pass through a standard 5/16in. soot blower nozzle at the various pressures in a given time.

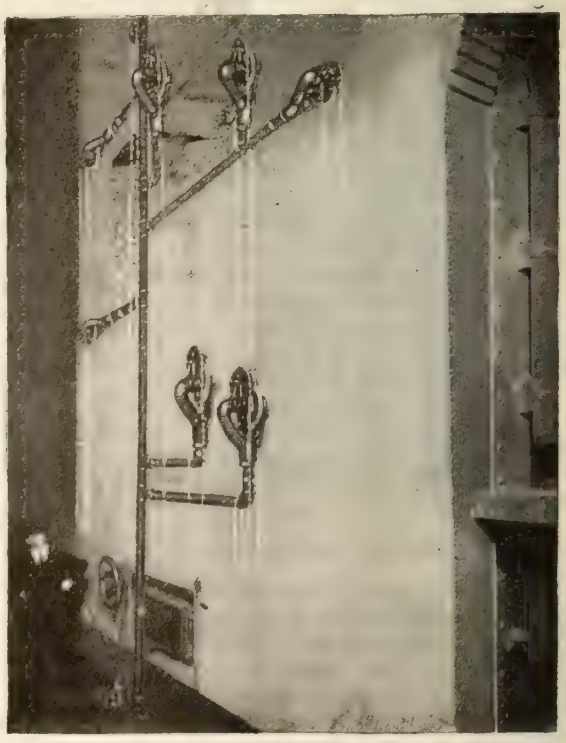

HEADER PRESSURE IN LBS WHEN BLOWING
20 40 60 80 100 120 140 160 180 200
15 SEC
30 SEC
45 SEC
60 SEC
75 SEC
90 SEC
105 SEC
120 SEC
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
STEAM CONSUMPTION IN LBS

Steam consumption for single 5/16 in. jet. Header pressure 40 to 200 lbs. when blowing. Valve 15 to 120 seconds.

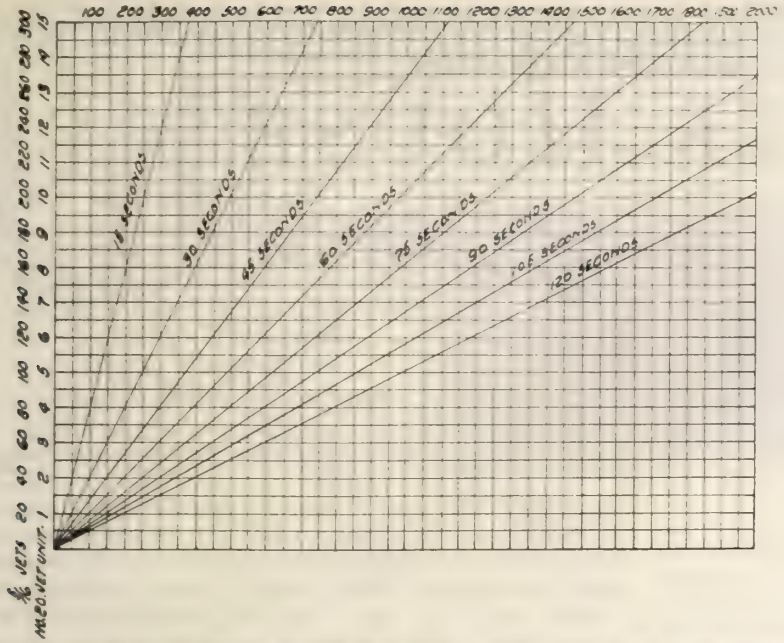
The point at which the slanting lines intersect vertical lines for a given pressure indicates the steam flow through the nozzle for the time marked on each slanting line. By this method we find that with 100 lbs. header pressure, 2.4 lbs. of steam will flow through a nozzle if the valve is open 30 seconds, while 9.6 lbs. will be used if the valve is left open 120 seconds. Taking a standard 21 wide B & W boiler, we find we have five units of 20 jets each or 100 jets. To blow this boiler by the valve-in-head



Steam consumption in lbs. per 5 units on boiler 21 tubes wide. 100 lbs. header pressure. when blowing.



Valv-In-Head Soot Blowers.



Steam consumption per unit for boiler 21 tubes wide. Header pressure 100 lbs. when blowing. Valve open 15 to 120 seconds.

system with the valves open 30 seconds each will require 240 lbs. of steam, while with the independent valve soot blower if the valves are open 120 seconds each, 960 lbs. of steam will pass through. If the boiler can be properly cleaned with the valves open 30 seconds, the loss would be 720 lbs. per blowing, or 2,160 lbs. in 24 hours, if the blowers were used three times a day. With the boiler in service 300 days a year, the steam loss would be 648,000 lbs. To reduce this loss to dollars and cents it is only necessary to multiply the cost of the steam from 20 to 70 cents per thousand lbs., by 648. If the steam costs 50 cents per thousand lbs., the loss for the boiler described above would be $324.00 per year.

The chart, Fig. 3, shows the total steam consumption for a five unit 21 wide installation, on which the header pressure is 100 lbs. with the unit valves open from 10 to 130 seconds. Figure 4 shows the total steam consumption of installations on a 21 wide boiler with 100 pounds header pressure, having from one to fifteen units and blowing from 15 to 120 seconds each. From this it will be seen that a boiler with 14 units, having 20 jets each, and with 100 lbs. header pressure, will require 690 lbs. of steam per blowing, if the valves are open 30 seconds each, while 1,725 lbs. will be required if the valves are left open 75 seconds each.

It should be noted that the pressures given are for the header while blowing. With one unit valve open the header pressure will be from 50 to 80 per cent. of the boiler pressure, depending on the size of the piping, the bends and valves in the line, the number of jets on the unit and other conditions. The header pressure will always be somewhat higher than the pressure in the blower element, due to friction between the header and the element and in the element. This will also account for the discrepancies between these charts and the results obtained by the use of Napier's Formula.

These charts have been compiled from data collected while making tests on soot blowers at one of the largest power plants in the United States under conditions which assure their accuracy.

HELP FOR RUSSIAN ENGINEERS

The following circular letter has been received by "Power House," and as there may be among our readers some sympathisers with Russia in her present troubles, we are re-printing it just as received. The letter is issued by the Engineering Section of the Society for Technical Aid to Soviet Russia, 110 West 40th Street, New York. We are not aware who is behind this society, and it may be noticed that no names are given, even the secretary neglecting to give his name. Under these circumstances, we leave it to our readers to judge the letter on its merits.

Dear Sir:

The Engineering Section of the Society for Technical Aid to Soviet Russia has been requested and appealed to by the Russian scientific and engineering societies for books, bulletins, pamphlets and current literature on the scientific and industrial progress in the United States, particularly since 1914.

Our individual members have donated toward a fund created by the engineering group in order to send such literature to Russia. The demand, however, is so great and the needs for the latest available scientific and technical publications are so urgent for Russia's industrial rehabilitation, that they cannot be fulfilled by the Engineering Section of the S. T. A. S. R.

We, therefore, take the liberty of requesting you to aid us in answering this appeal from Russia, and if possible send us back-numbers of your publications as well as recent ones, since your publication has been mentioned by the engineering and scientific societies of Russia as worthy of technical and scientific reference.

We are mindful of the fact that America has already done a great deal toward the alleviation of the starvation sufferings of Russia, and we trust that by issuing this appeal in the name of Russian scientific and engineering societies we will not have taxed the generosity and kindness of the American people.

We are certain that in the very near future, when Russia shall have returned to normal conditions, the Russian engineering and scientific societies will gladly reciprocate and send free of charge their new publications, if not to all, at least to replenish the files of the American libraries, which are at present incomplete without the latest publications from Russia.

Many of our readers, possessing your publication might be willing to contribute it for this worthy purpose, and we take the liberty to suggest that you give this appeal editorial mention.

Thanking you in advance for your courtesy, we remain,

Very respectfully,

Secretary, Engineering Section.

BRITISH HYDRO-ELECTRIC INSTALLATION

A water power station with some original and most interesting features has just been completed in Scotland. A small head of water had been used for a long time in driving two mills by old-fashioned breast wheels. Owing to the increasing demand for power the question of reorganizing the installation became pressing. It was eventually decided to use the water power for generating electricity and to augment the supply of water power by arranging a high level reservoir into which the water could be pumped during the hours when the mills were not working. Actually the mills work for about 50 hours per week. During these working hours the water runs down from the high level reservoir through the same pipe up which it had previously been forced, and it drives a Pelton wheel which generates the additional power required. This plan has frequently been discussed by hydraulic engineers, especialy in connection with tidal power schemes; but this is the first time it has been actually carried out. The results have been entirely successful and reflect every credit upon the engineers who designed and carried out this novel scheme. The equipment consists of two low pressure turbines of 110 horse power each, while the Pelton wheel runs at 1,000 revolutions per minute and drives a 155 kilowatt generator.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field. Steam. Electricity and Refrigeration.

TORONTO, APRIL 5, 1922

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Pride In The Job

IN ANOTHER section of this issue is a letter from a correspondent, taking us to task for making what appears to him to be invidious comparisons between the saw mill engineer and the ordinary plant engineer. In order to show us that we were doing the sawmill an injustice, he sent along with his letter of protest a number of cards taken from the different units under his charge. These cards have been reproduced with the letter.

We have also written to the gentleman sending this asking him to give us for the benefit of our readers some more details of the plant and its problems, which we feel, cannot be anything but helpful to others. The point we chiefly wish to bring out in connection with this letter is the evident pride that our correspondent takes in his job and its responsibilities. He has the spirit which is necessary to every power plant engineer who is going to be a success in his business. The plant in his charge is not merely something that occupies him for so many more or less hours during a week. It is more than that. It is a standing testimony to the interest the engineer takes in it, and a reflection of his ability, or otherwise.

We remember an old chief engineer in our seagoing days, who at the end of a run, when the engines were finally finished with, used to walk down the ladder, and take a turn round the engine room, giving the engines little affectionate pats here and there on the way. To him, those masses of metal were something of himself, which responded to the treatment they received.

This is the spirit to cultivate, the spirit that makes the hours pass by like minutes, that sends a man home at night with the feeling of something done that has been worth while. The spirit that is reflected in the smoothness of the running of the plant under his charge. The spirit that makes itself evident the moment one steps into the engine room, and makes one say, "Here is the plant of a man who has pride in himself."

Call it self respect, "esprit de corps," or what you will, it has a wonderful influence on a man's life and a man's work. It is the same spirit which moved Paul of Tarsus when he said, "I am a citizen of no mean city." The engineer who possesses it may be in the smallest job in the country, but before the end of his career he is going to be not far from the very top.

Be proud of your job, and your job will show you reasons for being so.

Something Wrong Here

AN EMPLOYEE of a brickyard in Toronto was killed the other day while attempting to put a belt on a shaft while in motion. The end of the shaft projected beyond the pulley, and the unfortunate man was dragged, caught through his clothing on the end of the shaft, and practically smashed to

Some interesting facts anent the system of factory inspection were brought out during the inquest. First of all, it was established that no copy of the factory act had been exhibited in the place for over five years. It was over a year since there had been a factory inspector in the place. One factory inspector giving evidence, said the place used to be in his district, and when under his jurisdiction he had ordered some guards to be placed around shaft or pulleys. He had been to the factory since the accident, but didn't notice whether his recommendations had been carried out or not.

The inspector now in charge of this district admitted that he had not made any visit to the place before the accident, giving as his reason that he did not know of the existence of the factory. He stated that when an inspector took over a district, he had to hunt out the factories in it, as there was no list provided.

There is a strong supposition from the evidence given at this inquest that had this accident not occurred, everything would have gone on in the same old way until something did happen. Preventive measures were not considered, and it does not seem to have been any one's business to look into the matter. There is a safety league convention in Toronto this week, preaching the gospel of safety first. There is a factory inspection department, and there are inspectors appointed and drawing a salary for preventing just such accidents as the one under discussion, yet according to the evidence of one of these inspectors the department has no information of the factories supposed to be under its jurisdiction. The inspectors have to "hunt these places out."

What seems to be needed is a factory inspection department that will inspect.

Errors In Formulae

WE RECEIVED an enquiry from a correspondent this week anent an answer to a question in the issue of November 5th. He wanted to know where we got certain figures. Looking up the answer in question, for the moment we did not know where they came from ourselves, until we recognized that once again the staff in the printing department had introduced some figures from their own private stock. In this particular case they merely put a figure 3 in the front and a cipher at the end making 1,200 into 312,000.

We recognize the confusion that is caused in the minds of readers by these unfortunate mistakes, and are doing everything possible to eliminate such happenings. In a publishing house of this kind where such a large number of journals are published during a month, we have to work at high pressure. The ordinary compositor or linotype operator does not realise that a figure altered in a formula is a much more important matter than a letter misplaced in a word with which every one is familiar. We have also been handicapped to some extent by changes in the staff.

We would ask our readers to co-operate with us by calling attention to any error which may have got past us, and appears in print. We will on our part try to make it impossible for the reader to find any. We feel keenly any annoyance caused to a reader who has asked for information, and through a typographical error, gets something of which he cannot make head or tail.

The Operators' Point of View

STANDS UP FOR SAW MILL

Editor, Power House:

I am herewith enclosing some indicator cards (mostly from sawmill engines) which will be a surprise to you, according to your rating of sawmill power plants and engineers in your valuable paper. I note in reading your articles you always contrast the sawmill plant with some up-to-date power plant when describing the salient features of the latter. This has been the prevailing opinion about sawmill power plants

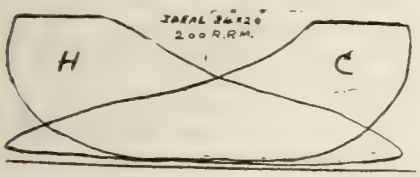


Fig. 1. Ideal engine made by A. L. Ide & Co., 24 x 20 inches 200 R.P.M.

until these last few years, and to-day some people still hold this opinion.

The sawmill of old usually had a few old boilers in a shed, and an old box-bed engine hidden in the saw-dust somewhere, barking out steam, and a chief engineer who could attend to the various duties of blacksmith, oiler, fireman, boiler washer, steeple jack and do his own brick laying and furnace work, which required brawn and not brain. Today the engineering department of a sawmill is the most important of all, as they have up-to-date engines, steam appliances for turning logs, controlling carriages, and giving motion to various devices such as raising bumpers, stops, rolls, and other heavy parts, that all used to be moved

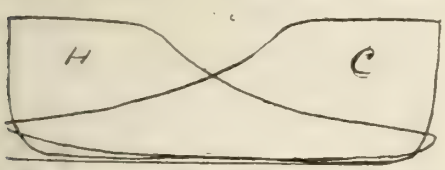


Fig. 2. 22 x 48 inch Murray Corliss engine, single eccentric.

by hand. In fact one of our mills had no less than forty-seven steam cylinders used for the aforesaid purposes.

There is also an air pressure to maintain in a modern sawmill. Right here we have a lumber trimmer with twelve air cylinders and air pressure is used for many other purposes.

Then comes electricity for lighting and power. The Big Rivers sawmill has a one thousand k.w. generator for power and a two hundred and fifty k. w. gen-

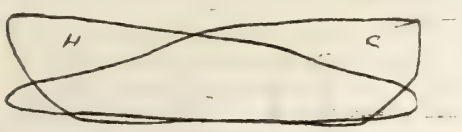


Fig. 3. Goldie & McCullough 16 x 24 slide valve engine, box red pattern.

erator for lighting, both direct connected to up-to-date Corliss engines.

Again there is the fire protection apparatus. We have here (at the Pas) five sprinkler systems with about 270 heads on each system with the necessary pumping equipment, tower tanks, etc., which are kept in working conditions (at a temperature of 50° below zero at times during the winter months). It must be taken into consideration also that sawmill boilers carry a higher pressure than formerly and are not usually situ-

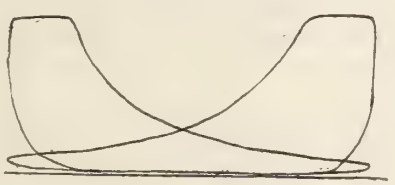


Fig. 4. Nordberg Corliss engine 24 x 48 inches. One eccentric for steam and exhaust, and a separate eccentric for knock off gear. This is set in line with crank giving practically full stroke range of cut off.

ated in a locality favorable for good feed water in this western country, which entails considerable work and extra care to keep boilers clear and in good condition for work and sometimes a large overload has to be carried on same.

We also design some of our equipment, have the patterns made and do the machinery of same right on the ground, so that saw-mill engineers and equipment should have a better rating than is credited to them in most tech-

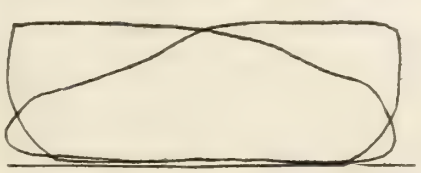


Fig. 5. Twin slide valve engine 16 x 22, built by Houston, Stanwood & Gamble, Cincinnati.

nical journals, and I think, Mr. Editor, that if you visited a real saw mill you would agree with me and not give all the superiority to hotel power plants as in your issue of Power House for February 1922.

Yours very truly,
Allen Norgrove
Chief Engineer
Pas Lumber Co.
The Pas, Man.

BANKING FIRES

By James E. Noble

Before banking the fire, the grates should be cleaned and what fire remains should be piled against the bridge wall upon the back shelf of the grates. Fresh coal is then added in a thick layer over the banked fuel and the fire is left with the ash pit doors closed, the fire door open and the damper closed or nearly so. The closing of the ash pit and the opening of the fire door makes the ignition of the bank of fresh coal very slow, so that some time will elapse before it has become ignited, when it will burn slowly.

In starting up, the fire should be cleaned and spread, when it is ready for the next run. Banking fires, in operating return tubular boilers, is a thing nearly every engineer has done some time in his life, and it is a surprising thing to learn in how many different ways the job is done. Each man seems to have some little kink of his own devising, which he feels sure, in his own mind, tends to make a good bank better.

In the event of restricted coal production in the States, as a result of the miners ceasing operations, it is expected that adequate supplies will be received from Britain to take care of Canada's needs. Inquiries are now being made in London freight circles as to rates on coal shipments to Canadian ports.

Large additions will be made to the cold storage plant at Grimsby, Ont. For several seasons this warehouse has been operated under the direction of the Dominion Department of Agriculture as an experimental plant, but has been turned over to the Growers' Cold Storage and Ice Co. Under the new arrangement the capacity of the warehouse will be quadrupled, and improved refrigeration will be installed, as well as mechanical facilities for the manufacture of ice.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

C.A.S.E. Competition Questions

Toronto No. 1 Lodge

Q.1. What is meant by the total heat of steam? How is this calculated?

A. 1. Total heat is the heat required to change water from 32 Fahr. to steam at 212 Fahr. It is calculated by latent heat plus the sensible heat.

Q. 2. What instruments are necessary for conducting a capacity test on a boiler? Give a description and reasons.

A. 2. Scales for weighing coal also one for weighing water, or meter it. Two tanks, thermometers, calorimeters, draft gauge, barometer, rheostat, phychometer, watch or clock.

Q. 3. What additional instruments are necessary for plotting a heat balance?

A. . Steam-flow meter, recording pressure and temperature meter, also recording C O$_2$ meter, vacuum gauge in cases of condensing.

Q. 4. Give a description of how you would proceed to conduct an evaporation test and sample log for recording essential facts?

A. 4. Raise steam to working pressure, remove quickly all fire from the grates and clean ashpit as quickly as possible, start a new fire with weighed coal and wood, noting the level of the water in the gauge glass and marking it just before lighting fire. During the test weigh all coal and water taking the temperature of the feed water from the tanks at each filling, also maintain the height of water at the same level during test at the end of test draw fire and weigh the ashes and fire drawn, water level, should be the same as at commencement of test and everything should be kept as uniform as possible and a record of every occurrence taken. Time of each firing, amount of coal used at each firing and time taken to consume each firing. (Sample log at end.)

Q. 5. What is a steam flow meter? Give description and operation.

A. 5. A flow meter measures the amount of steam passing from the boiler.

Q. 6. Explain why with an orifice and U tube the fluctuations are in direct ratio to the flow of steam?

A. 6. Because of the relation of flow or velocity to pressure; or the dynamic to the static pressure, by reason of which the differential is transmitted to the chamber where electrical contact is registered.

Q. 7. Why is mercury used as a measuring agent in preference to any other medium?

A. 7. Because its specific gravity is not easily subject to change by freezing or evaporation and its P. T. O., coefficient of expansion.

Q. 8. Give reasons why in your opinion steam flow meters are necessary for boiler operation and also why the fireman should be conversant with their use?

A. 8. By means of steam-flow meters it can be readily determined if the boiler is delivering its rated capacity, and more accurate determinations as to evaporation may be arrived at. (Efficiency rating).

Q. 9. What reasons have you for advocating the use of the steam flow meters in the various departments?

A. 9. To distribute the cost to each department according to steam used by each department.

Q. 10. Why is it more desirable to have a meter on the steam header than on the feed water and what information would you expect to get if you had both lines metered?

A. 10. The meter on the steam header would register the steam sent to the users and the meter would not record what would be lost by blow-downs, leakage of valves or safety valve, blow offs.

Sample Log for Conducting Evaporative Tests.

Test made by..... City.....Date.....
For (concern)..... Plant:.....
Kind of Boiler..... Make.....
Size ..... Cap. .....
Kind of fuel .....Hand or Stoker fired?
Grate Surface ..... sq. ft.
Kind of Furnace ..... Dimensions.....
Heating Surface ..... Sq. ft.
Conditions at Start .....
Conditions at Finish .....
Time (test) begun .....Time finished.....
Allowed for ..... Duration of Test?.....
Weight of Coal as fired .....lbs.,
.....% Moisture; .....% Ash;
.....% Sulp; ..... % Combustible.
Weight of Combustible .....lbs.;
Moisture .....lbs.; Ashes.....lbs.....
Total Water Evaporated .....lbs.;
Avg. Temp. of Feed Water .....°F
(Factor of Evap. .....)
Equivalent Evaporation .....lbs.
(from and at 212°F); Avg. Steam Pres., obs. .....lbs.
Rate of Combustion and Evaporation or its equivalent. .....
Dry Coal Consumed per hr. .....lbs.,
Equiv. .....lbs. (per hr.) per sq. ft. of grate surface.
Water Evaporated per hr. .....lbs.;
Equiv. .....lbs. (per hr.) per sq. ft. heating surface.
Equivalent Evaporation per hr. .....lbs.;
Equiv. .....lbs. (per hr.) per sq. ft. heating surface.

NOTE—Conditions observed; average pressure and temperatures, etc. .....

Ste. Pres. (obs.) .....lbs.;
Exhaust Pres. (obs.) .....lbs.;
Vac (ifs.) .....inches= .....lbs. absolute.
Temp. F. W. to Heater.....°F;
Temp. of F. W. to Economizer .....°F;
Temp. F. W. to boiler .....°F.
Temp. of furnace..... °F; Temp. flue gasses .....°F; Temp. of steam.....°F
Saturation.....?
Superheat.....?
Air Pres. (forced) .....oz.;
Draft over fire ..... inches;
.....% Saturation; .....° Superheat.
Physical results of list also relative efficiencies determined:—
Mfgs. rated capacity of boilers....H.P.;
Guaranteed Evaporation .....lbs. per lb. coal.
Horse power developed during test.....;
(Water Evaporated (lbs.) ÷ 34½ = H. P. ÷ hrs) .
Calorific value of 1 lb. dry coal.... B.T.U.;
Water Evaporated per lb. coal .....lbs.
Calorific value of 1 lb. Combustible.....
.....B. T. U.; Water Evaporated per lb. comb. ..... lbs.
Boiler Efficiency based on lb. coal as fired (F. W. .....°F= % Eff.
Boiler Efficiency, based on combustible (F. W. 210 °F) = % Eff.
Boiler Efficiency, based on B. T. U. Value and C O^2 Record = % Eff.

Economic Results obtained:

Total heat saved by return of Condensate (by traps) ..... B. T. U. Value.....
Total heat saved by use of Exhaust Ste. (F. W. Heat) .....B. T. U. Value .....

Total heat saved by use of Flue Gases (Economizer) ..... B. T. U. Value..... Cost of Coal per Ton $..... Cost of Coal per lb. c.....; Cost of Combustible (per lb.) ..... Value of 1 lb. coal ..... B. T. U.; Total heat value of Ton Coal.... B. T. U. = ... per B. T. U. Cost of Coal per H. P. (hr.) developed .....; Cost of Labor per H. P. (hr.) developed ..... Int. and Depreciation Charge on Heater $.....; Int. and Depreciation Charge on Economizer $..... Net Saving Effected by Heater $.....; Net Saving Effected by Economizer $ .....

NOTE.—Savings may be effected not only by the use of the heat of exhaust steam and flue gases, but by the introduction of automatic damper regulators, C O^2 recorders, and steam flow meters all of which may be treated in the same way as the gains shown by use of F. W. Heater and Economizer.

Combined efficiency of boiler and engine may be determined more readily by the use of steam flow meters than by any other method.

ORDERING PISTON RINGS

Question: — Would you inform me through the Question Box the correct way to order piston rings for steam cylinders, also gas engines. How does one give the dimensions?

Answer:—The dimensions necessary are the depth, width, and the diameter of cylinder bore. This will be sufficient for the machinist to make the ring from. Piston rings should always be turned slightly eccentric, that is they should be thinner radially at the point where they are cut than at any other point. This is to allow them to assume a truly circular shape when in the cylinder. The amount is very slight, and many rings are made without adopting this precaution, especially in small sizes.

HEATING SURFACE

Question:—What is the ratio of heating surface to cubic foot of air space? Is it standardized throughout Canada?

Answer:—The amount of heating surface per cubic foot of air space will depend on the temperature inside of the coils, and the temperature of the room to be heated. A pound of air has a volume of 12.36 cubic feet, and the specific heat of air is .24. Therefore to raise 12.36 cubic feet of air one degree .24 B, T. U. will be required, or 1 B. T. U. will raise one pound of air 4.165 degrees, or one 4.165 lbs. 1 degree in temperature. The heat loss from coils is usually taken as about 2 B. T. U. per degree difference per sq. foot heating surface per hour. Suppose we had a room 10 x 10 x 8 or 800 cubic feet, and we wished to raise the temperature from 0 to 70 degrees. The B. T. U. required would be

$$\frac{800 \times .24 \times 70}{12.36} = 1085$$

and if the coils contained steam at 212 degrees, then 212—70=140, and if the loss was 2 B. T. U. per square foot per degree difference per hour, that would give us 280 B. T. U. per hour, and 1085 divided by 280 would be 3.8 square feet or say 4 square feet surface. If hot water were used instead of steam about 8 feet would be needed. If the air was to be changed twice an hour double the amount of surface would be required.

SAFETY VALVE SPRING

Question:—Referring to the 5th November article issue, page 40. A boiler has two safety valves each 3½″ in dia., size of wire is ⅝″ square. What should be the allowable pressure on the boiler, the grate surface, the diameter and length of spring?

You don't show the allowable pressure here, you show 9.6 x 125 = 1200 lbs. = the load on spring and one formula for the spring of a safety valve is

$$d^3 = \frac{S \times D}{C}$$

Where d=diam. or side of wire.
S=load on the spring in lbs.
C=11,000 for square steel.

Now we come down to

$$.625 = \frac{31.200}{11.000}$$

Where do we get the 31.200? What is it?

I am enclosing another formula, which I cannot follow. Can you explain it? G. K.

Spring ⅝ = .39 = 600 or 1/16 of breaking load.

$$\frac{600 \times .39}{25} = \frac{23,400.00}{25}$$

$$= 936 \text{ lbs.}$$

$$\frac{936}{9.62} = 97 \text{ lbs.}$$

$$97 + 15 = 112$$

$$\frac{37.5}{112} = .334 \text{ area of valve.}$$

in square inches to grate surface in sq. feet.

Outside diameter of spring

$$\frac{.625 \times 3}{.5} = 3.75$$

Length of spring

$$\frac{.625 \times 11.5}{.5} = 14\tfrac{3}{8}$$

Answer:—In the working given in the November 5th issue, a pressure was assumed, and the rest of the dimensions calculated from that. The figure 312,000 was a misprint, and should have read 1,200, as can be seen by the remaining part of the formula.

In the formula above that you have sent along, the working pressure has been found by making another assumption. Here the working strength of the spring has been assumed to be 600 lbs. per square inch. The .39 is the square of .625, and 600 × .39 gives the strength of the section assuming that 600 lbs. per square inch is allowed on the metal. The 25 given in your copy of the formula should be .25, and is the cube of .625.

This is as far as we can see without any explanation, and this has been used to get the load on the spring, given as 936 lbs.

If we apply this load to the formula for the mean diameter as given by recognized authorities we get

$$d = \frac{S \times D}{C}$$

where d is the diameter or side of wire, D the mean diameter, and C a constant 11,000 for square steel.

This gives, using the figures for the load as found in the formula you have sent

$$.244 = \frac{936 \times D}{11,000}$$

$$\text{and } D = \frac{11,000 \times .244}{936}$$

which gives a mean diameter of 2.8 as against 3.75 given by your formula, a little further down.

If we take the mean diameter as found by your formula 3.75 and apply it to find the load we get

$$d^3 = \frac{S \times 3.75}{11,000}$$

$$\text{and } S = \frac{11,000 \times .244}{3.75}$$

$$= 715 \text{ lbs.}$$

The results obtained do not agree with each other.

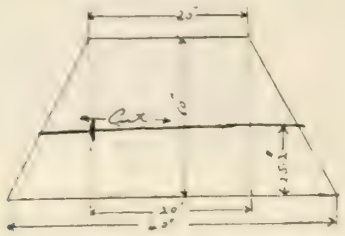
We should be glad to have the explanation of this working for the information of our readers.

A MENSURATION QUESTION

Question:—Please work out the following problem by arithmetic. I have worked it out by Algebra but would be glad if you would work it out as requested. How would you figure out where to cut the following sheet of iron so as to have the same weight in both pieces, the cut to be made in the direction of the drawing?

Answer:—We have in this figure prac

tically a parallelogram 60 inches high and twenty inches wide, and two triangles, each sixty-inches in height by 10 inches base. These can be considered as



one triangle with a base of 20 inches and a height of 60 inches. The centre of gravity of the parallelogram is at half its height, while the centre of gravity of the triangles is at one third its height. The height of the centre of gravity of the triangle is then two thirds of the height of C. of G. of the parallelogram, and the difference between the two heights is one third of the height of the centre of gravity of the parallelogram.

We then have two thirds of the weight concentrated at one half the height, and one third of the weight concentrated at one third the height. If we divide ten inches, the diference between the two by three, we have 3.333 inches, and twice this is 6.666. If then the centre of gravity of the one third is moved up two thirds and the two thirds moved one third we get a mean centre of gravity of 26.666 from the bottom.

A line cut across this point will not give us an equal weight each side, although that is the spot where the centre of gravity is concentrated, and if suspended thereby would be perfectly balanced.

We would have a parallelogram measuring 31.111 inches on the top, by 40 inches on the base, the area of which is 40 plus 31.111 × half the height, which is 13.33 inches.

This 31.111 plus 40 × 13.333=945.88 square inches area. We have thus an excess of 45.88 square inches below the line of the centre of gravity, and the area above will be 854.12 square inches. At the width of the figure 26.6 inches from the bottom, it would require a depth of 1.47 inches to give the requisite amount of area, that is we should have to subtract 1.47 from 26.6 to give the position of the line of cut. The width however increases by .333 inches for every inch nearer the bottom of the figure. We would have then a parallelogram with a mean width 35.8 and a height of 25.19 inches from the bottom, which would give us an area of 901.802 square inches. If we subtract .03 inch from 25.19 we shall get the exact division. Thus 25.16 height and a mean width of 35.8 gives

$$25.16 \times 35.8 = 900.728$$

which is close enough for all practical purposes.

Suppose we take the areas direct without finding the centre of gravity. We have taken areas on each side of the centre line horizontally, first

$$35 \times 30 = 1050$$

and the top part

$$25 \times 30 = 750$$

Thus we have a difference of 300 square inches between the top and bottom halves. That means our dividing line must be brought down below the centre, an amount sufficient to give an area of 300 square inches. Now if the figure were the same width all the way, we should simply have to move the line down 15 inches. We have, however, a gradual increase in width at the rate of one third of an inch in width for every one inch we approach at the base. At 20 inches from the base we should have a width of 33.333 inches, and the width at 25 inches would be 31.666. Assume this to be the width and divide it into 300 we have 9.47 inches. Taking half of this we have 4.735 and subtracting this from 30 we have 25.265. We have then practically the same result as before.

SPEED REGULATION

Question:—An engine runs at 236 revolutions per minute when under full load, and 240 revolutions when under no load. What is the percentage regulation to the governor? How would you make such a calculation, and why would one desire to ascertain this percentage?

Answer:—The percentage of regulation would be found by the proportion of the full load revolutions to the no load revolutions as compared to 100, and subtracting 100 from the result. Thus

$$236 : 240 :: 100 : x$$

$$\frac{240 \times 100}{236} = \frac{24000}{236} = 101.78$$

Subtracting 100 from this gives 1.78 per cent. increase, and this is the percentage of regulation.

In electric lighting plants, where the load is unsteady, the closeness of regulation to the governor is important, as otherwise the lighting will be subject to flickering. Again, if there are a number of motors on the circuit which are being thrown on and off, or their load is subject to sudden fluctuations, if the governor cannot regulate the speed of the engine closely, the voltage would be liable to rise very suddenly, with perhaps such results as burnt out insulation, or at least blown fuses, or the throwing out of circuit breakers. Such engines are therefore usually specified to have a regulation of 2 per cent. from full load to no load.

COOLING SURFACE IN CONDENSER

Question:—I have obtained through the Question Box information on the work done by a particular machine in tons of refrigeration, and I would like to obtain the following information. How much condenser of the double pipe system is required for one ton refrigerating capacity? In a direct expansion system how many square feet of cooling surface can be handled by one ton refrigerating capacity? (Any temperatures can be used for example). In speeding up a machine to increase its capacity, on a system that is deficient in condenser surface what is the result?

Answer:—The usual allowance for double pipe condenser is 20 feet of 1¼ pipe per ton of refrigeration. This is equivalent to about nine square feet of cooling surface per ton. The rate of heat transfer from ammonia depends on the temperature of the cooling water, and the velocity of the water passing through the pipes. This velocity is of course dependent on the pressure, and an increase of water velocity at the same temperature conditions will give an increased cooling effect for the same amount of surface. While there are many factors influencing the heat transfer, the temperature and velocity are the principal ones, and this amount of cooling surface has been adopted by leading makers as the result of wide experience, to suit average conditions.

The number of square feet of surface that are required in the direct expansion coils will depend on the temperature. To produce one ton of refrigeration per twenty-four hours with a condenser pressure of 139 lbs. and temperature of 80 degrees, and a suction pressure of 16 lb. and zero temperature, 3.74 cubic feet of gas must be pumped per minute. Assuming that the liquid in the coils is fully evaporated, and the coils were 2 inches inside diameter, there would be 3.74 x 1,728 equals 6,642.72 cubic inches. This divided by the area of the pipe which is 3.1416, is 2,057 inches or 171.4 feet. This is equal to 95 square feet surface. A ton of refrigeration is 288,000 B. T. U. per 24 hours, and 12,000 B. T. U. per hour, so with 95 square feet of surface in the direct expansion coils this would be equivalent to a heat transfer of 127 B. T. U. per square foot surface per hour. One authority gives as a fair practical estimate between 200 to 250 feet of 1¼ pipe per ton refrigeration. It is better to make a liberal estimate, to allow for operating conditions which may cut down the efficiency of the coil. The result of speeding up a machine with insufficient condenser capacity can be deducted by considering the action of the gas. It must be remembered that the heat taken up by the ammonia in the expansion coils or evaporator, together with the heat of compression, has to be rejected in the condenser. Speeding up the machine means that more gas has to be handled, and if there is not sufficient capacity in the condenser, the temperature and pressure on the condenser will build up. This means that the engine has to do more work, if the temperature and pressure of the evaporator or expansion coils is kept the same.

The extra temperature of the liquid passing the expansion valve will decrease the available refrigerating effect of the ammonia per lb., and the net result will be that you are handling more gas, and using more power to drive the machine, without any gain in cooling effect. The closer the condenser pressure and temperature are to the evaporator pressure and temperature, the less work has to be done by the machine.

CONCRETE MIXING

In some plants the jobbers do much of the repairs to the floors, etc. In laying concrete floors in boiler rooms the following item may help. In proportionizing, the following may be used. One part best Portland cement, 3 parts of clean sharp sand and 5 parts of stone, broken small enough to pass through a two-inch screen. In preparing the concrete, the sand and broken stone must be first carefully washed clean just before being used, then the cement and broken stone and sand are mixed together and an additional amount of water added by means of a spray to form a pasty mass. It can then be placed in position and pounded down with a light ram. The surface is then finished with a half inch coat of cement in proportion of two parts of cement to one part of fine clean white sand and finished with a floated surface. The body of the concrete should not be allowed to dry before the finishing coat is applied. The foregoing will give a good durable floor. Some men advise using sifted ashes, in a smaller proportion, instead of the sand, and well washed broken clinkers, instead of the stone. This will make a cheap job, and in appearance equally as good as the sand and stone floor, but like most cheap jobs, it will be far less durable, and much less liable to withstand the rough usage usually applied to boiler room floors.

Boring for oil is to commence at Bert McDonald's farm, Meadowville, Pictou County, N. S., the latter part of April. Pictou and Stellarton men are the promoters. A hole was sunk in the same vicinity some years ago, but was eventually abandoned.

At this month's meeting at Sydney, of the Cape Breton branch of the Engineering Institute of Canada, S. C. Mifflen, A.M.E.I.C., read a paper on the operation and equipment of the iron ore mines at Bell Island, Newfoundland. On the island five distinct seams of iron ore crop up, but only three are known to be workable. Within the past year the Dominion Iron and Steel Co., put in commission a turbo-electric power station of over 3,000 horse power. The power house is built on the sea shore line and a pier for storing coal is built about it, the foundations being laid in 18 feet of water.

The Muscle Shoals Project

Courtesy of "Universal Engineer."

IN ALL the stirring annals of the awakening South, no one event stands out like the great industrial drama of Muscle Shoals. To this vast, rich, but backward Tennessee Valley—"the Dimple of the Universe," as the romantic natives call it—the World War brought sudden, sweeping changes. Over night, almost, Uncle Sam poured thousands of men and millions of money into this smiling, sleepy region; at Muscle Shoals, near Florence, Ala., giant power and nitrate plants were rushed to completion to make powder for fighting Germany. Prosperity—a flood of government money and fat payrolls fairly engulfed all northern Alabama. At Sheffield, men paid a dollar a night for the privilege of sitting in a chair to sleep and tales are told of bold brokers who felt so flush that they even staked houses and lots in poker games.

Then the armistice—and the cold gray dawn of the morning after. Smoke ceased belching from towering stacks, for Uncle Sam had built and worked the plant only as a war emergency. So wheels stopped humming, the army of workers trekked over the hill, and the ghostly silence of ruined Pompeii settled down on rows of empty houses, on stores, theatres and churches—boarded up like Coney Island in January.

Yet here to-day stands a plant of marvelous potentialities, shut down, not because the country is not hungry for its product, but merely because Congress financed its operation only for the period of the war. Time and again, too, in years past, the engineers and power experts of the nation have called attention to the vast hydro-electric possibilities of Muscle Shoals. There is more horse power going to waste here, it is said, than has yet been developed in all other southern water-power developments taken together. Next to Niagara, engineers say, there is nothing like it in all our country.

The one outstanding war-time project which should be continued as a peace-time undertaking—at the same time retaining all its wartime functions for public safety—is this enterprise at Muscle Shoals, says the American Farm Bureau Federation's investigating committee in a recent report. There is no problem of conservation more vital, the report adds, than that of preserving the fertility of our soil; those who dwell in cities are of course as much concerned in our food supply as those who actually grow the crops.

In May last a special committee from the Mississippi Valley Association, sent to investigate the Muscle Shoals project, recommended that $10,000,000 be appropriated by Congress to carry on construction of the partly finished work. Congress failed to do this, and lately Mr. Henry Ford has offered to buy the project from the Government. Because of the magnitude of the undertaking and its importance to the whole nation a brief sketch of what has already been done at Muscle Shoals may be interesting.

The Tennessee River at the Shoals, from which it is planned to take power to operate the nitrate plants, and for sale to other industries, is as large—at average flow—as the Ohio at Cincinnati or the Mississippi at Dubuque. The banks of the river are of such a height that a 100-foot head of water may be held without building any retaining walls or dies, except the dam itself.

The big dam, known as the Wilson Dam, is about one-third finished and one-half paid for; when complete, it will be 4,426 feet long, 160 feet wide at the base, and will be the largest single piece of monolithic concrete construction in the world. Its height from the original river bed to the bottom of the overflow gates is 80 feet, and to the roadway on top, 133 feet.

The pool formed by the dam will extend about 17 miles upstream, and the total amount of land flooded by the water will be about 9,000 acres. This area has been practically all bought and paid for by the Government.

Two sections of the great dam, one at the north bank and one in the centre of the river on an island, are partly completed. The foundation is laid for nearly all the rest of the dam, and excavations for the power plant have been made. Two locks for navigation purposes are also partly excavated, each with a lift of 45 feet and with dimensions adequate for the largest river craft.

A fully equipped nitrate plant, known as No. 2, which cost $69,000,000 and with a capacity of 110,000 tons per annum of ammonium nitrate, stands near by. This giant cyanamid process plant covers nearly 2,000 acres, and during the war it employed 20,000 men. It was just rushed to completion and was producing nitrate in just one year—during the war.

Near by stands what is said to be the largest steam power plant in America. It was built so that this nitrate plant No. 2 could begin production without waiting for the completion of the Wilson Dam, which was expected to take about three years. This great steam plant produces nearly as much electrical energy as any other steam plant ever built, and contains one steam turbine unit with electrical generators which generate 60,000 kilowatts or 80,000 horse power. In addition there is provision for a smaller unit capable of producing 40,000 horse power, or a total for the entire steam-power electric plant completed of 120,000 horse power—ample to operate the electric furnaces in another part of the plant.

The boiler room of this immense plant holds a battery of fifteen units, each rated at 15,000 horse power. It burns 1,500 tons of coal per day—but is so remarkably equipped with automatic stokers and other devices that ten or twelve men can easily operate the whole plant.

All told, Uncle Sam has spent on this project a total of about $105,000,000.

This amount, however, includes the cost of a nitrate factory known as Plant No. 1, near Sheffield, where the Haber process was employed, but which was given over largely to experiments.

Such, briefly, is the great Muscle Shoals project as it stands today. Peace has come, and in peace the lessons of war are forgotten; already we have forgotten that when the Great War started we had powder enough for less than three hours' fighting—and had to bring our nitrate all the way from Chile! But even in peace, every day adds its acreage to our growing area of worn-out, abandoned farms, farms which only artificial fertilizers can restore to speedy production. Let us see, then, what the completion of this dam might mean to American agriculture.

Though we are the richest nation on earth, in agriculture we have burnt the candle at both ends. At first we farmed only the best soil, or moved farther west, or grew content with smaller returns as farms began to wear out. Today however, our population is increasing twice as fast as our crop production—we simply must grow more food, or eat less! As long ago as 1898, Sir William Crookes, then president of the British Association for the Advancement of Science, pointed out that the world's food consumption was running beyond the capacity of the cultivated land producing it. The only way world starvation could be averted, he said, would be by the universal use of a bountiful supply of fertilizer containing that most valuable element, nitrogen.

Keeping The Soil Young

Every wise American farmer now knows that the fertility of his soil depends upon the phosphoric acid and potash, and in a greater measure, upon the nitrogen it contains.

But because in the beginning we had virgin fields and fertile lands in such abundance, we were careless in our farming methods; and today we find that we have robbed vast areas of once good farming land of that nitrogen which only centuries can restore by natural processes.

Plain as this fact is to everybody, we must yet confess that America, despite her wealth and progress, is at least fifteen years behind countries like Germany, Norway, Canada, France, and even Japan in the production of nitrogen fertilizers. Though we have paid Chile to date nearly $850,000,000 for nitrates, and though we have a wealth of water power and a host of electric furnaces, till very lately we had not made one pound of air nitrates for use on our hard-taxed soil. Of all great nations we, the poorest of all nitrogen paupers, are practically the only one which has not seized this beneficent gift of science—a gift that can save us from inadequate crops and ruinous food prices. Germany alone has built up an air nitrate industry with an annual output of millions of tons freeing her forever from dependence on Chile, insuring her bountiful food crops, powder in plenty when needed again, and even actually enabling her to export this product of the air and sell it for good money.

So, no matter who may finish the Muscle Shoals project, the day it starts making air-nitrates will be a red letter day in the annals of American agriculture. But it will be only a beginning—for even if developed to maximum capacity, this plant could hardly produce one-fifth of our actual needs. Georgia alone could use a million tons a year. Undoubtedly one of the greatest industries in all America, in the future, will be the production and distribution of artificial fertilizers: eventually our needs must become so imperative that perhaps the central government itself will be compelled, in order to save the nation from going hungry, to take control of the fertilizer trade to develop other power plants like the one at Muscle Shoals.

You can visualize the importance of nitrate to this nation when you stop to reflect that our average corn crops takes from our soil about 3,000,000,000 pounds of nitrogen; that a 15,000,000 bale of cotton crop uses up 500,000,000 pounds of nitrogen; that every year, all our crops together probably use up 6,000,000,000 pounds! Of course the alchemy of nature is always at work, restoring this lost nitrogen, but it does not work fast enough to keep pace with the constant needs of growing crops.

Then, too, with enough cheap power we might free our farmers from enslavement to the German Potash Trust. Under the whole Allegheny Range, geologists tell us, there lies a deposit of "Georgia shale," so named from the enormous deposits in northwest Georgia, which run from 8 to 12 per cent. in insoluble potash. By electric furnace treatment the potash in this shale becomes soluble; so we might in time either free ourselves entirely from dependence on Germany or at least force down the arbitrary high prices now charged by the German Syndicate.

A Fortunate Location

As for the third element in a complete fertilizer, phosphoric acid, this is also now obtainable by breaking down phosphate rock in electric furnaces, instead of by the less practicable method of using sulphuric acid. Fortuitously, too, one of the largest phosphate rock deposits in the United States lies adjacent to Muscle Shoals, at Mount Pleasant, Tenn.

It is hard for the average man to understand how anybody, even a sleight-of-hand performer, can take a hatful of air and pull an ounce of nitrogen out of it. It is a trifle easier to grasp, maybe, after you've been through the air-nitrate plant about six times and had it all demonstrated to you, but even then you keep wondering how the first fellow ever came to think of it. One guess is that he reasoned backwards—back to the simple peasant habit of "plowing under" clover or bean vines to "rest" a tired farm, simply nature's way of fixing atmospheric nitrogen by taking it out of the air and putting it in the soil in tubercules on the roots of legumes. This is just what man now does, by the use of machines and the power of chemistry.

And whether you want air nitrates to make gun-powder or to fertilize your potato patch, their process of manufacture is the same.

For ninety years or since 1831, both Alabama and Uncle Sam have been spending money on locks and canals along the Muscle Shoals stretch of the Tennessee River. Just now, however, all navigation is blocked here by the partly finished dam. When complete, the vast inland lake created by the dam will enable the largest river craft to pass easily over the inundated shoals; great locks will pass such craft through the dam, and then the vast rich basin of the Tennessee, with its coal, limestone, coke, iron, lumber and farm products, will be tied up with the 13,000-mile network of navigable inland waters of the Mississippi basin.

Army engineers have estimated that the cost of the improvement at Muscle Shoals, properly chargeable to navigation should be about eight and a half millions.

They say that the improvement of the river for navigation alone would cost more than its present traffic would justify; but when coupled with an industrial development that means cheaper fertilizer, cheaper electric power for sale, a big plant on which the Government might depend for nitrates in case of war, the river improvement seems to be very much worth while.

This, briefly, is the plant Mr. Ford has offered to buy. Should he do so, it will be perhaps the largest transaction of its kind ever closed. Here is what he offers:

To lease water power equipment for 100 years, at a price that will pay the Government 6 per cent on the estimated cost of completing the two dams, or $28,000,000.

To pay the Government annually a sum that will in 100 years retire nearly its entire war-time investment on water power.

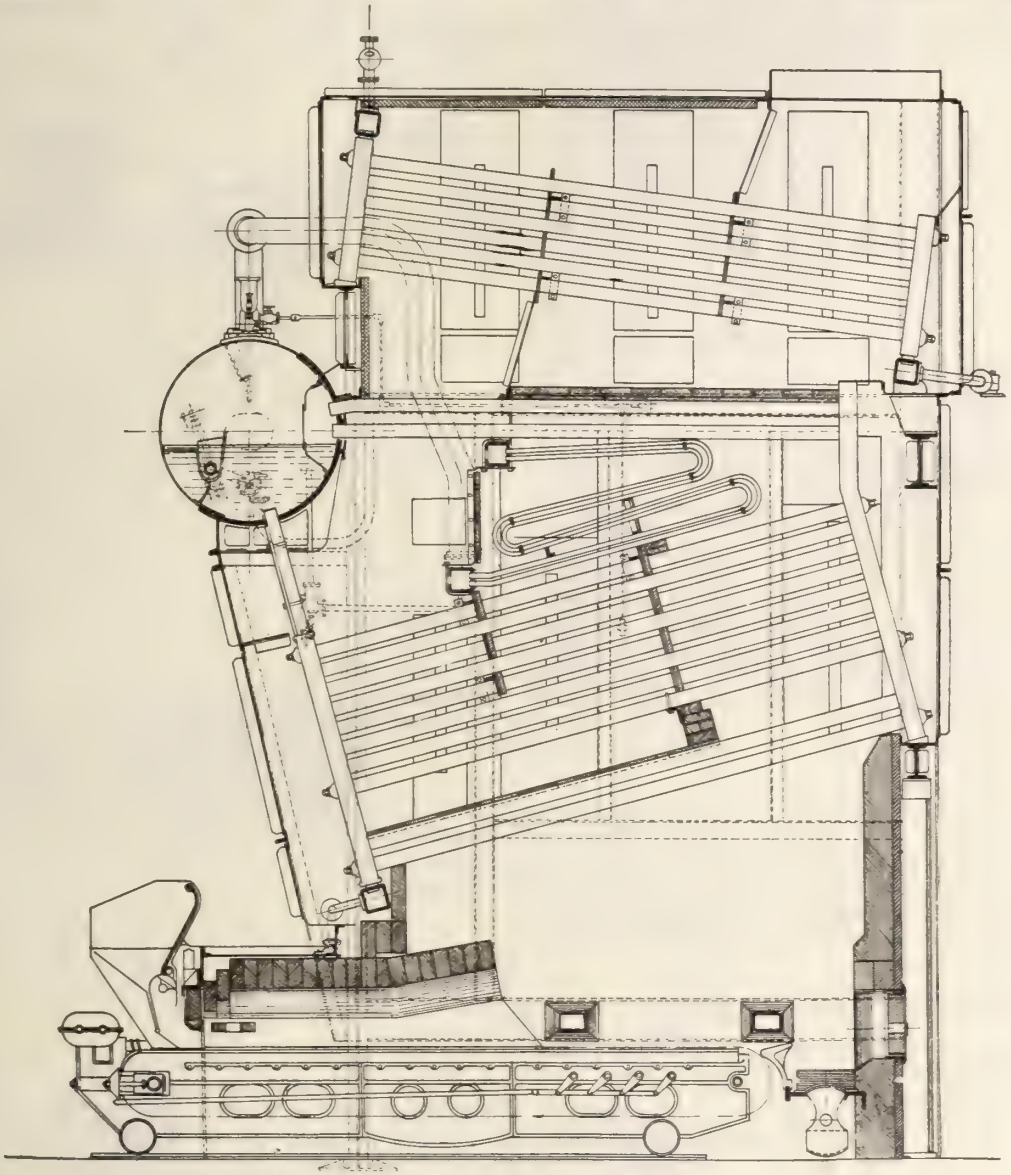
To buy nitrate plants and other property for $5,000,000 cash.

To pay the estimated cost of upkeep and repairs on the dam and water-power equipment and furnish free power to operate the navigation locks.

To make nitrates in Plant No. 2, to conduct researches for keeping the plant up to date in developing cheaper fertilizer producing methods, and to limit fertilizer profits to 8 per cent.

Such is the story of the power and value of falling waters at Muscle Shoals, Niagara of the South. Nowhere, perhaps, has Nature set her stage more favorably for a vast, industrial drama. I have shot wild guineas amid the ruins of Babylon, where Sir William Wilcocks dammed the Euphrates to water the farms of Mesopotamia; I've fished for bass above the giant Roosevelt Dam and I know the Valley of the Nile, with its modern miracle at Assuan. But I know no other power or irrigation site, where the wealth and strength of nature seems so peculiarly assembled and ready for man's use, as here at Muscles Shoals.

High Efficiency Boilers



(Cut lent by courtesy of Eng. Institute of Canada.)

MARINE BOILER---ADAPTED FOR LAND PURPOSES---EQUIPPED WITH CHAIN GRATE STOKER, SUPERHEATER and SUPERPOSED ECONOMISER

The construction embodies the same well-known principles as the standard type; freedom of circulation and economy when forcing being important factors of both designs. It has the added advantage that a large amount of boiler horse-power occupies a relatively small floor space.

This type is particularly useful for central stations and other plants where turbines are used and the working pressure is high. It operates economically under the special conditions of variable loads with heavy peaks. A big increase in efficiency over smaller boilers is effected through a reduction of radiation and other losses.

The individual Economiser superposed on this boiler increases the efficiency, reduces the flue gas temperature and effects considerable saving in space and of many of the losses incident to the use of separate economisers.

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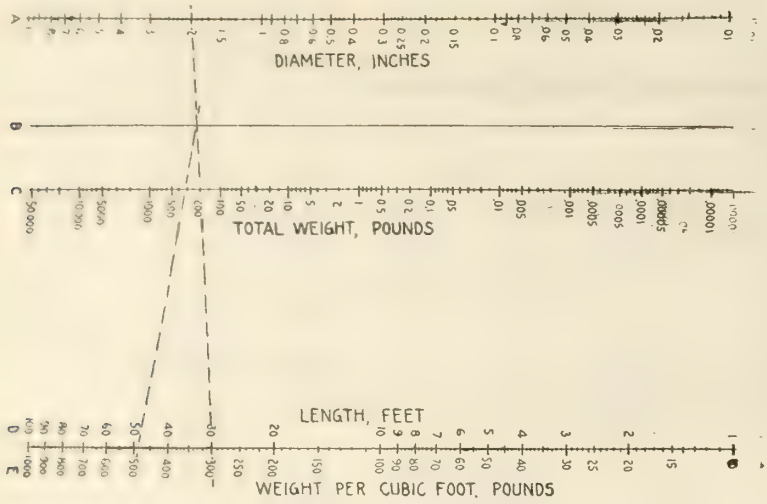
WEIGHTS OF METAL BARS

By W. F. Shraphorst

The accompanying chart provides a convenient method of determining the weights of solid or hollow metal bars of ordinary dimensions. By means of a straight edge placed across the chart as shown by the dotted lines, the weight may be easily found. The chart shows the result for a bar of mild steel 2 in. in dia. and 30 ft. long. The table herewith shows the weight of mild steel to be 487 lb. per cu. ft. By connecting the 2 in. column A with the 30 in. column D, and working back from the intersection on line B over the 487 in. column E, the point where the straightedge cuts the column G will be the desired weight; in this case 320 lbs. By calculation the weight is found to be 318 lbs.

The weights of common metals mostly used in industry are as follows:

Aluminum	lbs. per cu. ft.	165
Brass		534
Copper		556
Wrought iron		485
Lead		710
Nickel		537
Mild Steel		487



The chart may be used vice-versa if desired. If it is required to know the length of bar that will weigh a certain number of pounds the reverse process would be necessary.

For hollow bars the same method would be followed, calculating the inner and outer diameters and deducting the former from the latter.

Payne Deane Ltd., New York, have issued a bulletin describing their remote control and remote control indicators for gate valves for water systems. The bulletin is No. 43A.

PIPE THREADING MACHINE

A 12 in. threading and cutting machine that can be equipped for threading oil well casing and hydraulic pipe has been placed on the market. The normal range is from 4 in. to 12 in., but may be adapted to cut pipe 2½ in. in dia. The range is accomplished by means of two die heads, each head having only the one set of chasers. The die head or carriage may be moved either by hand or power, one operating lever controlling the traverse in either direction. Automatic safety stops are provided for the carriage travel. The reaming tool is quickly set to position and locked with a lever. The reamer is fed to the pipe by rotating the cutting off feed hand wheel in a counter clock-wise direction.

The machine has a single pulley drive. The variations of speeds, eight in number, are obtained in the speed box, located under the main spindle, by shifting levers on the side of the gear box. The machine is started and stopped through a friction clutch by either one of two levers located at the extreme ends of the head stock. This enables the operator to start or stop the machine when threading or when fitting up flanges. A lever is located midway between the starting and stopping levers for reversing the machine. The chucks for gripping the pipe have three jaws. These jaws are geared and have universal adjustment. They are also self-centering to the pipe. The rear chuck is equipped with flange grips for fitting up flanges.

Is made by the Landis Machine Co., Waynesboro, Pa.

STILL IMPROVING THE LOCOMOTIVE

The locomotive, now about a hundred years old, was a British invention; and to-day engineers continue to introduce improvements in its design. Over forty years ago a device known as the "exhaust steam injector" was brought out. Its purpose is to use the power in the exhaust steam from the cylinders to force water into the boiler. The first injector of this kind was able to do its work against a pressure in the boiler of 70 lbs. per square inch. Later it was improved so as to feed at 120 lbs., and for higher pressures it was necessary to call in the aid of live steam from the boiler itself. Lately, however, a British firm invented a modification by means of which the injector can work against a pressure of 150 lbs. per square inch with one pound of exhaust pressure, thus effecting a great economy in live steam. This improvement is due to the use of an additional nozzle which brings the steam into more effective contact with the stream of water. In practice the amount of live steam required when this new device is fitted is nearly half what it was formerly and amounts to only 2½ per cent. of the total steam produced by the boiler.

The development of the power plant of Manitoba Power Co., it was stated at the annual meeting held in Winnipeg, is progressing very satisfactorily, over 500 men being employed on the works. The transmission line from the Winnipeg Electric Company's hydro-electric plant to the work, a distance of 17 miles, has been completed, and power is now being used in connection with the construction work. The orders for the hydraulic and electrical equipment have been placed. The turbines are being made by the Dominion Engineering Co. at Lachine, Que., and the generators by the Canadian General Electric Co. The switchboard and the Kingsbury bearings are being made by the Westinghouse Co.

The city of Sault Ste. Marie, Ont., is having plans prepared for the installation of two gasoline engines for direct connection to present pumps in the pumping station. Cost to be about $20,000.

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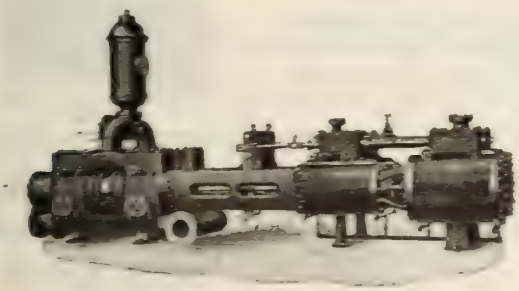

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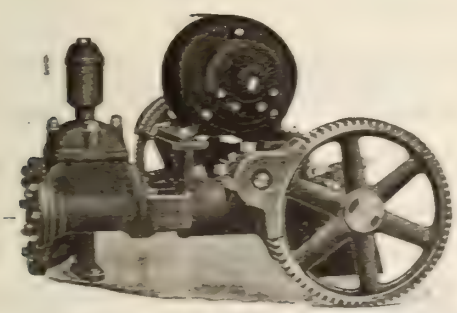
WATER WORKS PUMPING ENGINE



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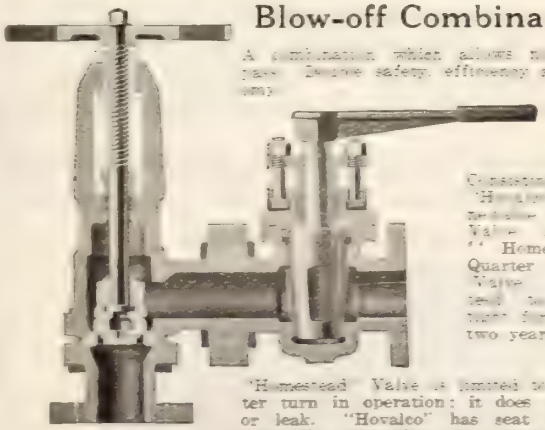

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Homestead, Pa.

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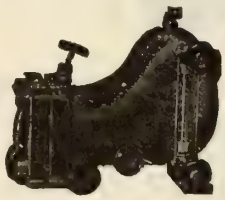

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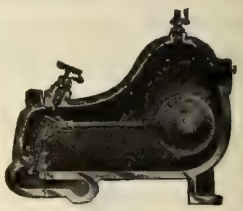

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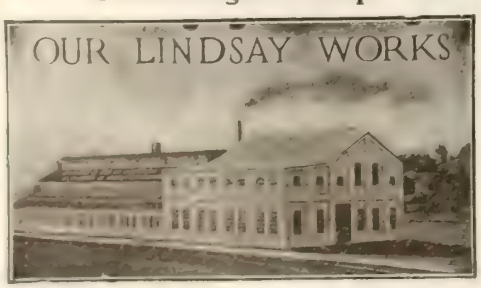

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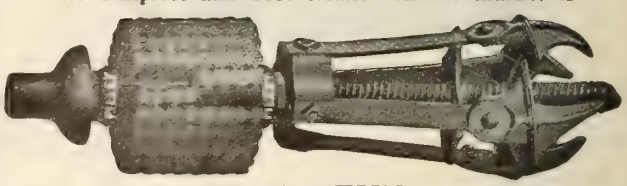

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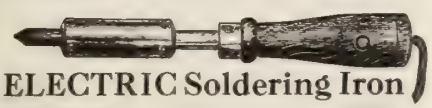
VIMY  ELECTRIC Soldering Iron

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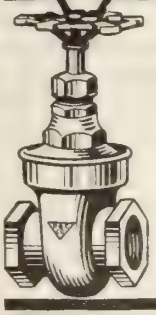

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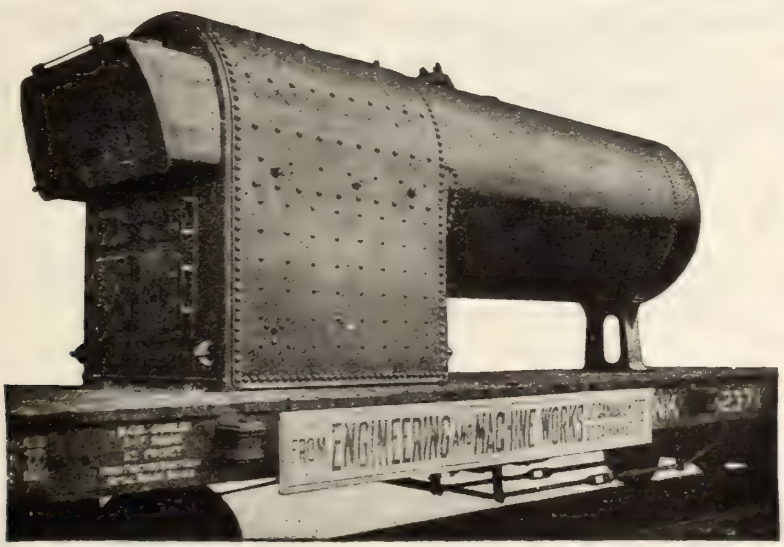

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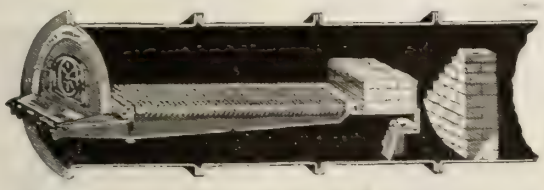

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Some contains very little moisture, but cottonwood contains 66 2/3 per cent. as an average, and sometimes more.

At the plant of the Laminated Materials, Ltd., the home of "LAMATCO" Wall Board, New Westminster, two boilers were required to burn this fuel to keep up steam with the assistance of $400.00 worth of purchased fuel.

A set of Turbine Furnaces was installed, with the result that one boiler, **without** the use of purchased fuel, is all that is necessary.

Manufactured by
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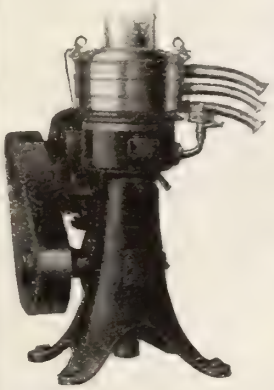
Stop Wasting Oil

The De Laval Oil Purifier returns to service lubricating oil or transformer oil which would otherwise be thrown out. Better still, its continued use constantly maintains the efficiency of such oils.

The De Laval does its work instantaneously, thoroughly and economically by centrifugal force. It is the modern method of making turbines and Diesels give longer and better service, and of prolonging the life of the oil used to lubricate them. It is the far more economical method of maintaining the dielectric strength of transformer oil.



No matter which of these tasks you give a De Laval—you can use the same machine for both — you have absolute assurance that the work is being done better and more economically.

Write for Bulletin No. 105

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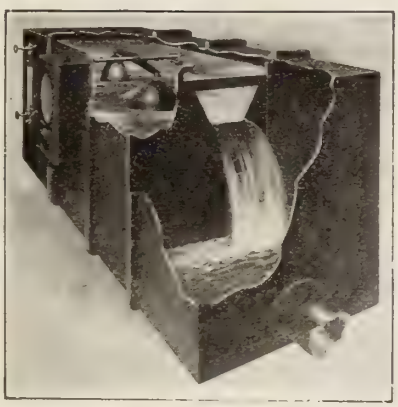
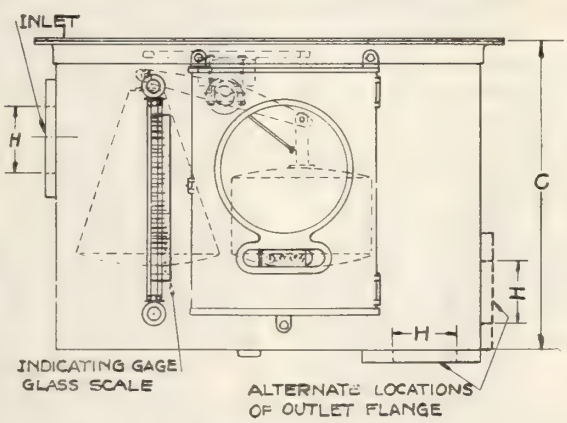
The Simplest Construction Always Proves The Most Accurate!





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Accurate and long lasting because free from troubles and inaccuracies arising from the use of cams, springs, flexible connections, racks, gears, roller guides, etc. Every plant needs it for measuring feed water, condensate, and other liquids.

The Bailey Weir Meter indicates, records and totalizes the flow of liquids. A glance at the diagram above shows its remarkable simplicity. Can be also fitted for temperature recording. 12″ diameter uniformly graduated charts are used. Ask for bulletin No. 60.

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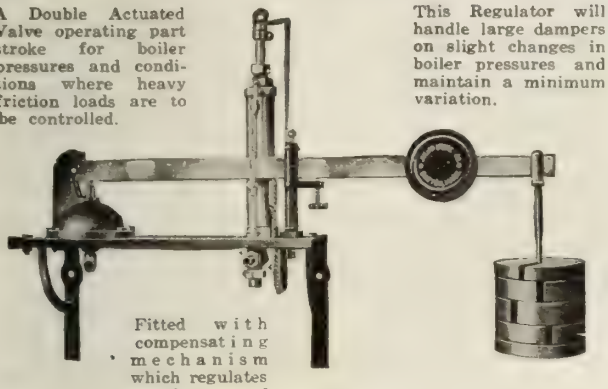

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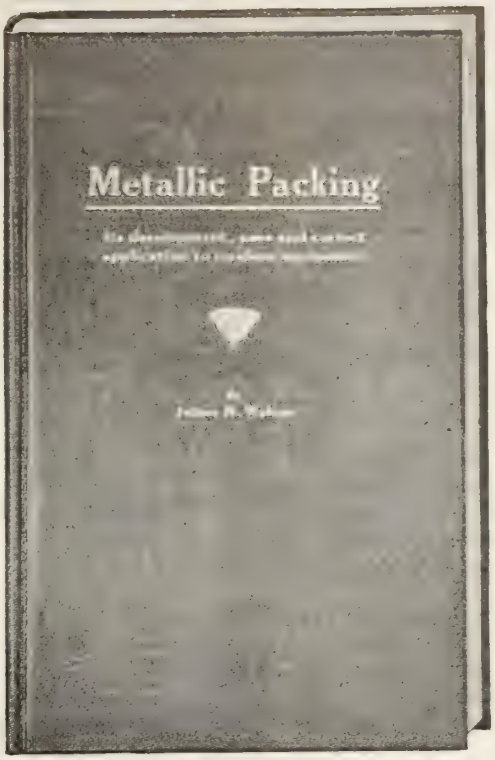

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Must be Rugged

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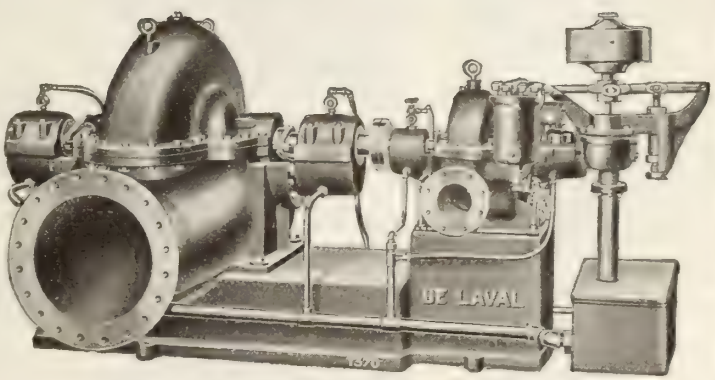
State class of apparatus in which you are interested and appropriate literature with special data will be supplied. Ask for Catalog F100.



De Laval velocity stage turbine driving single stage gas blower; 11,000 cu. ft. of free air per min. against 33 in. water column at 3,600 R.P.M.

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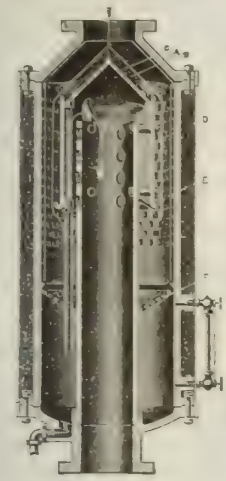

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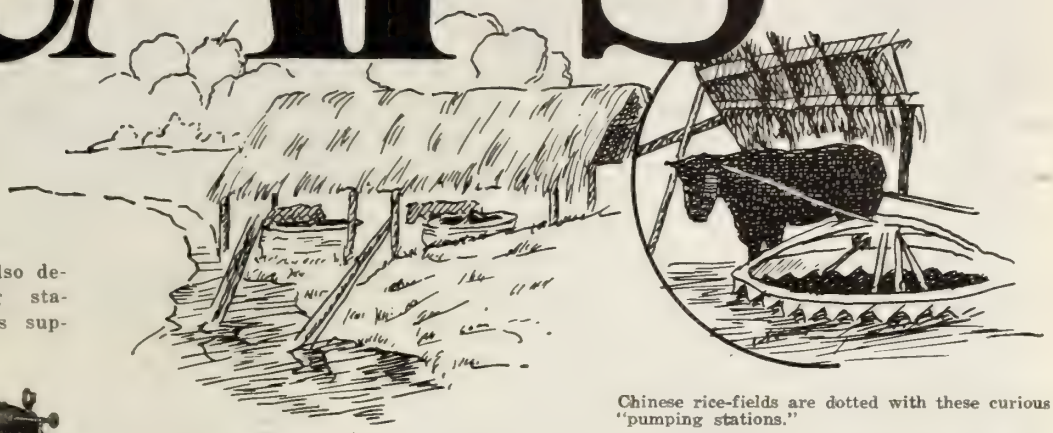

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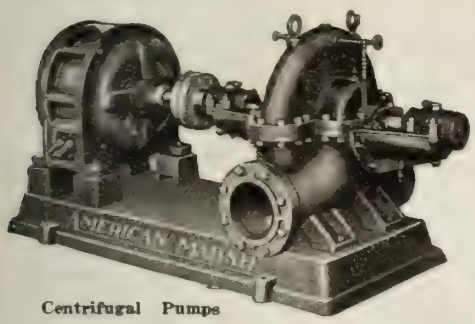

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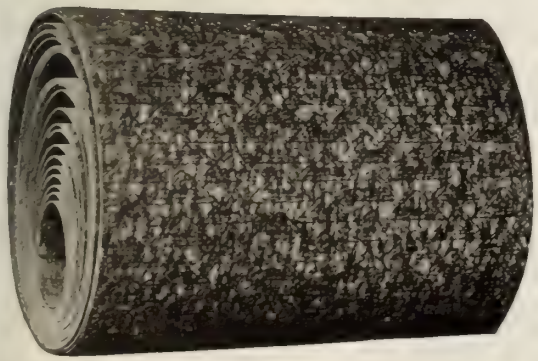

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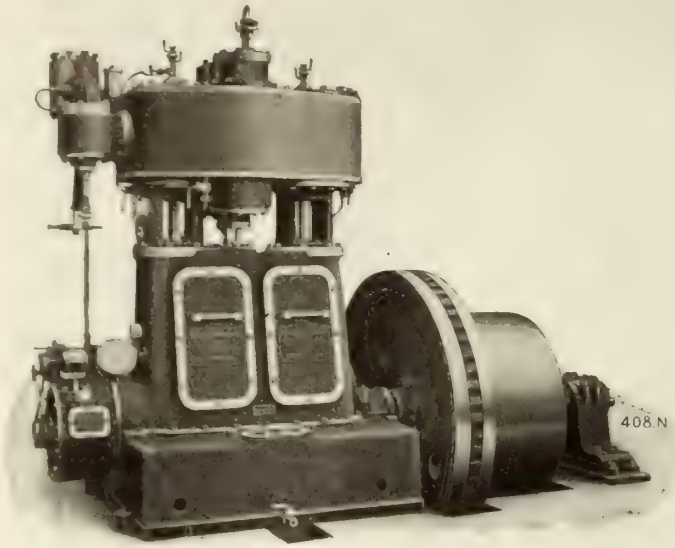

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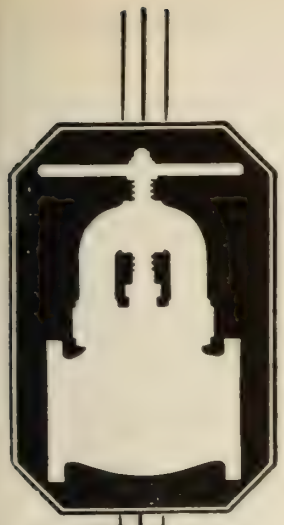
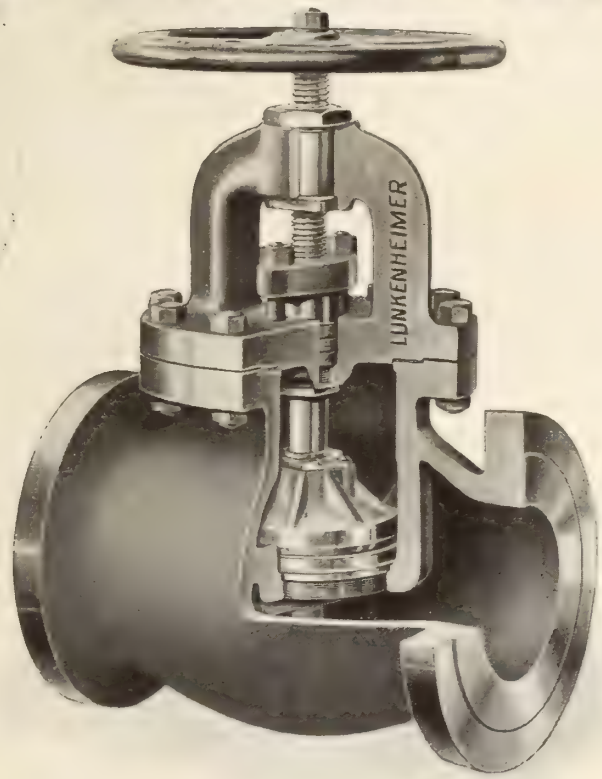


LUNKENHEIMER

Globe, Angle, Cross and Check Valves



Extra Heavy, Fig. 884.

Standard, Fig. 1123.

Service economy—long life with a minimum cost for upkeep—is the dominant factor which has led to the selection of LUNKENHEIMER Iron Body Valves as "standard equipment" in many leading plants. Their success in service is the direct result of the combination of correct design with proper materials and the Lunkenheimer method of manufacture.

LUNKENHEIMER "Valve-iron" and Lunkenheimer "Valve-bronze" are formulated especially for valve service and the Lunkenheimer method of manufacture insures dependable results under prescribed operating conditions.

The line embraces a variety of types and sizes in Standard and Extra Heavy Patterns for pressures up to 125 and 250 pounds respectively, whose performance and durability fully measure up to the Lunkenheimer high quality standard.

There is a LUNKENHEIMER Distributor in every commercial center ready to give prompt service. Specify LUNKENHEIMER Iron Body Valves and insist on getting what you specify.

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TO successfully meet the requirements of high pressure steam something better than the ordinary globe or angle valve is required. Several basic constructional features of "Beaver" valves satisfactorily adapt them for this service.

The improved joint between body and yoke and machined faces of the double spigot prevent any possibility of gasket blowing out. There are large areas through body and seat—free flow of steam or water is facilitated. Minimum space occupied; renewable seats and other features recommend "Beaver" valves for the hardest service.

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"Every Installation a Demonstration of Merit"

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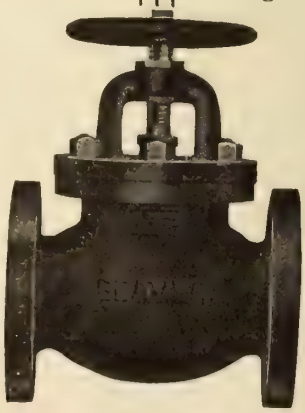

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STOKER NUMBER

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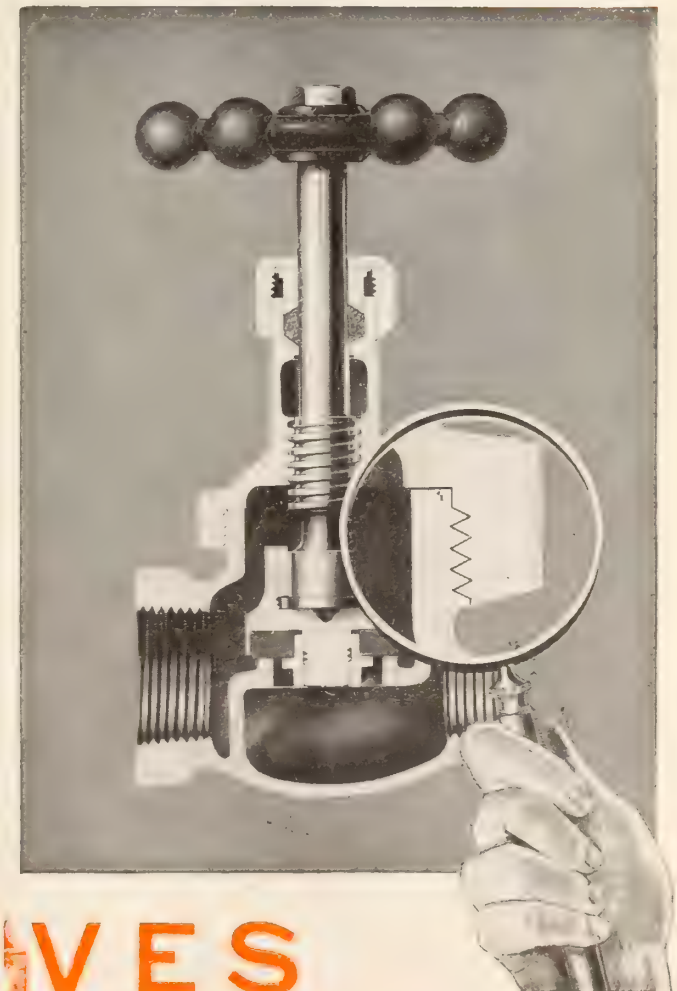

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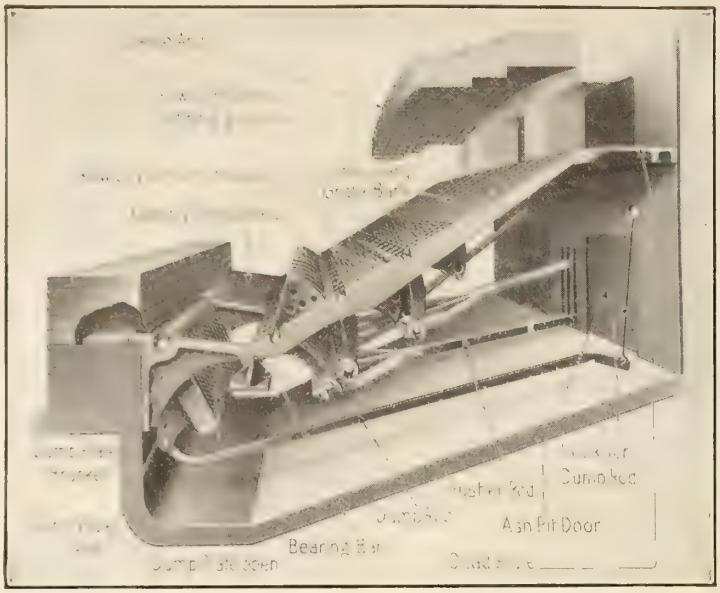

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The heavy labor of firing is eliminated and low grade labor with very little training can get results all the time, day in and day out, that experienced stokers can only get part of the time. Any grade of fuel can be used—smoke is eliminated with all grades of coal—no fuel in the combustion chambers—no ashes in the flues—increased boiler capacity—and much lower labor cost are National advantages. The banks of Pushers, operated by rods from the front of the furnace keep the fuel moving downward until the dump plates are reached—insuring just about PERFECT COMBUSTION and a degree of efficiency and economy in your Boiler room that will delight you.

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Cut 10% or more off Fuel Expenses

After exhaustive investigation, these experts (without exception) placed the stamp of their approval on Nonpareil Shaking and Dumping Grates.

These Grates give complete combustion of every pound of coal—65% air space, 95% underdraft, low grade fuel.

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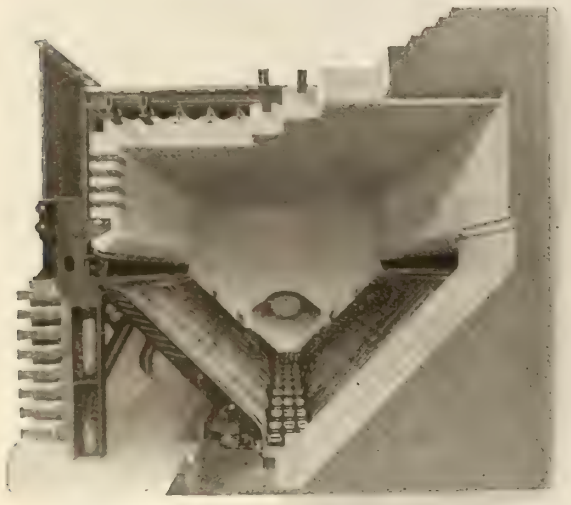
Renewals and Repairs made for all kinds of Shaking and Dumping Grates for all sizes of Boilers

DETROIT "V" TYPE STOKERS



Detroit "V" Type Stoker, Heavy Duty Type, with Detrick Flat Suspended Arch (rear view)

Quarter-section, Radial Stoker and Arch Stoker, showing Coal Magazine and arch support, with removable tuyeres and protecting brick

The special Fire Brick shapes furnished with Detroit Stokers are made from the highest quality refractory material, molded by hand in steel molds and repressed to insure uniformity and durability.

Secure Complete Combustion

You have gone to large expense in installing up-to-date equipment in your plant, to insure economy in operation. How much of the potential energy in your fuel are you actually utilizing in producing steam?

Very much less than you could or should if your boilers are hand fired!

Compare some of the advantages of Detroit "V" Type Stokers over uneconomical hand firing!

A. Hand firing is intermittent, its evenness and effectiveness depending upon the individual skill and attentiveness of the fireman. With Detroit "V" Type Stokers the human factor is eliminated; firing is continuous and uniformly even, assuring high combustion efficiency.

B. With hand firing, one fireman can at the best take care of 250 to 500 H. P. of boilers, whereas with Detroit Stokers the same man can handle 2000 to 3000 H. P. thus reducing labor costs 75 per cent.

C. Detroit "V" Type Stokers burn cheaper grades of fuel than can be used to advantage with hand firing, thus paying for their cost several times over each year.

In addition consider the advantages of control of air admission, thorough automatic cleaning of fires, and smokeless operation, resulting from a Detroit Stoker installation.

Detroit Stokers today represent the best fruits of a practical knowledge gained in the Company's twenty years of successful stoker building, and the recent important developments in the science of combustion. There is a type for every purpose—"V" Type overfeed for natural draft—Single Retort Underfeed for boilers developing up to 300 to 400 H. P.—Multiple Retort Underfeed for large installations.

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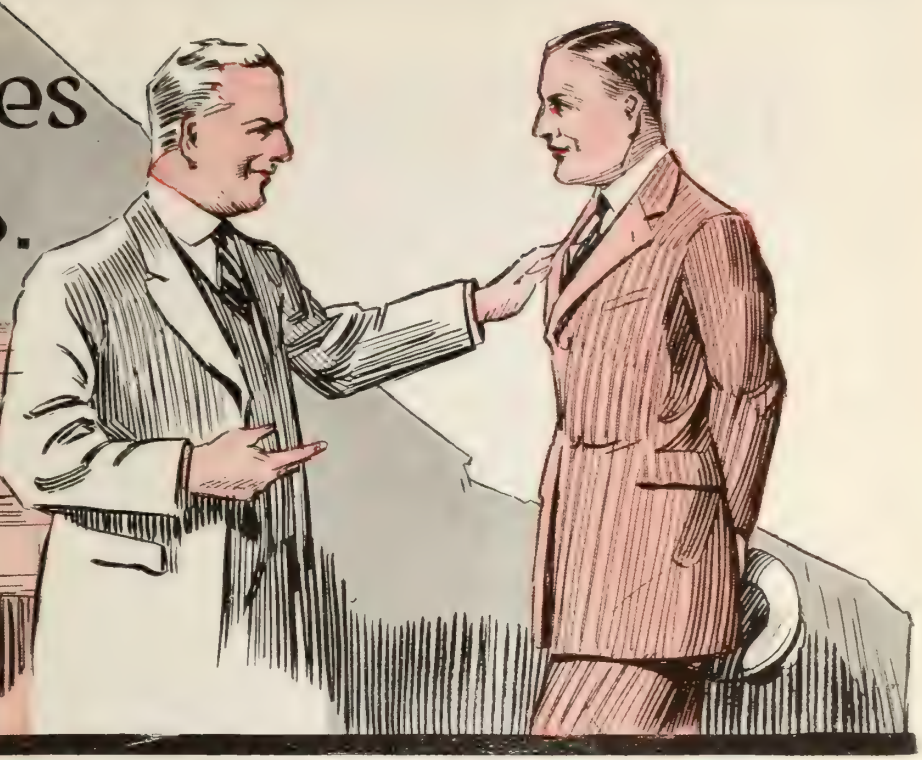

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This suspended arch can be constructed in almost any form desired to meet special requirements.

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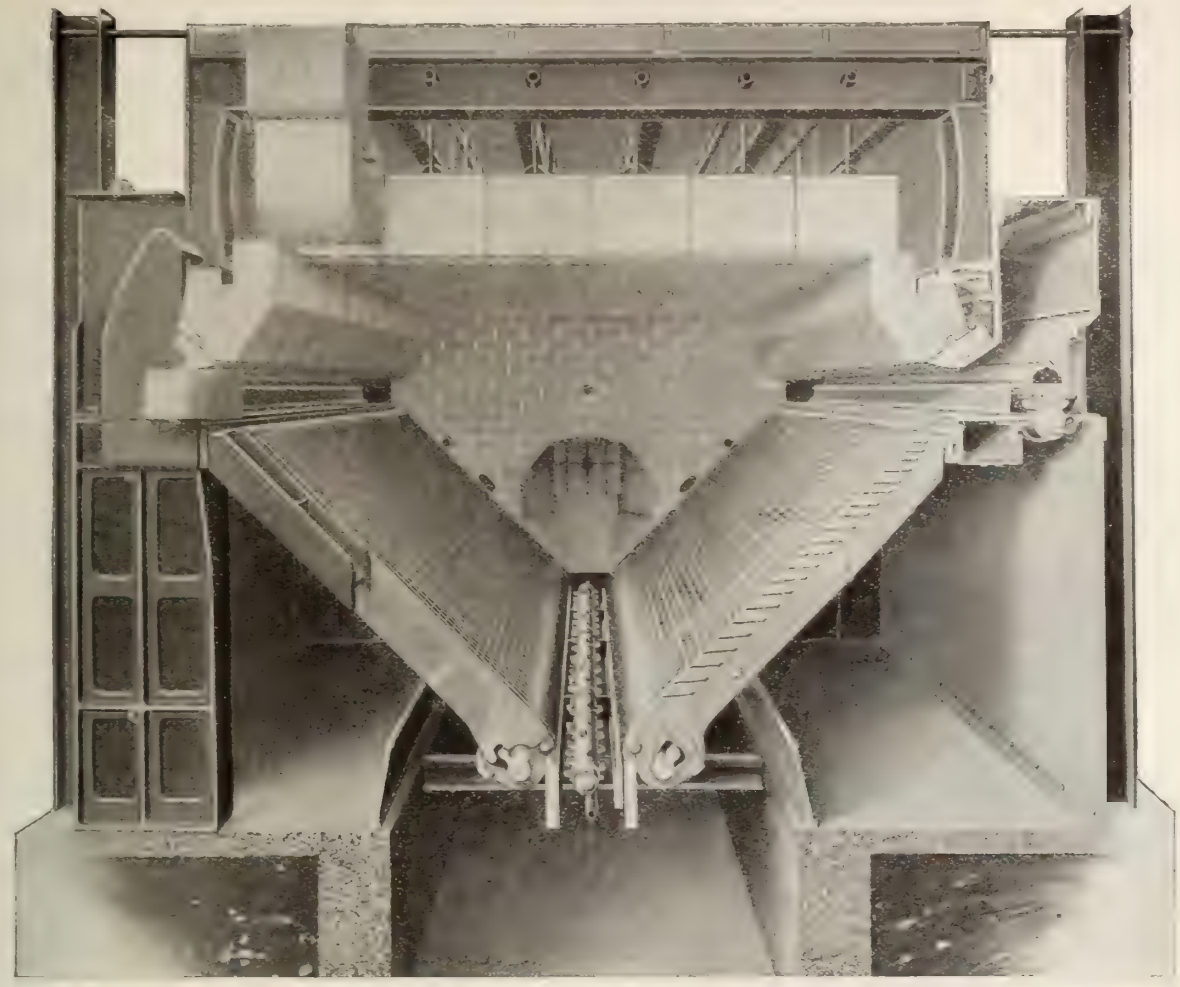

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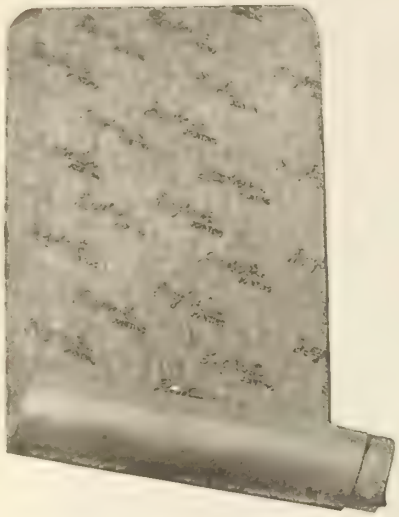

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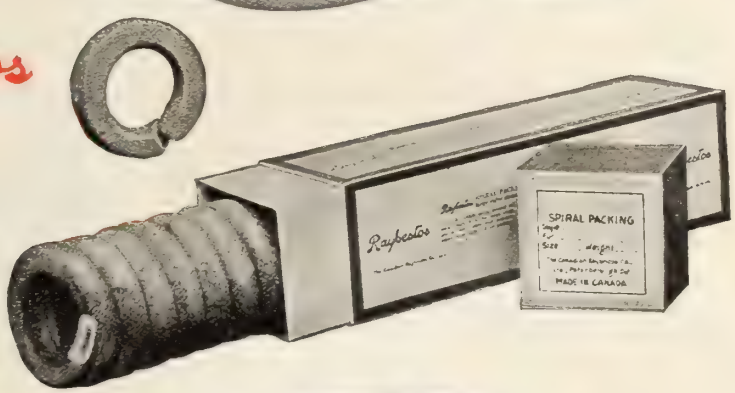

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Increasing their steam output and reducing the cost of steam per thousand pounds, the Illinois Watch Case Company, Elgin, Illinois, has demonstrated that modern factory standards pay big dividends when applied to a boiler room.

This well known company makes watch cases on a quantity production basis. Every modern test and standard of manufacturing equipment is in use in the factory.

These same standards are applied to their boiler room—the steam factory department.

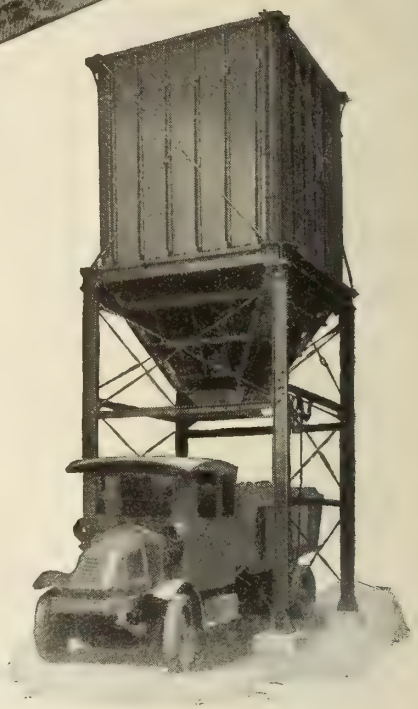
Green Chain Grate Stokers are used. The results are expressed in Mr. I. B. Eppenstein's letter of Aug. 17, 1921.

> "Prior to installing Green Chain Grate Stokers we consumed approximately 12 tons of coal per day, and furnished power for only a small portion of our plant. The balance of the power being purchased from a public service company.
>
> "Since the installation of Green Chain Grates in our new power plant, we supply power to the entire factory, no power at all being purchased, and consume approximately 10 tons of coal per day.
>
> "Our saving on coal amounts to about $184.60 per month."

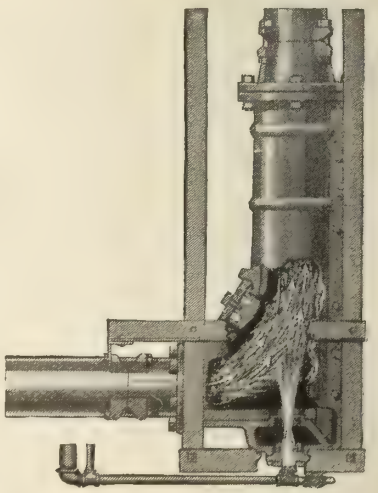
Green Chain Grate Stokers maintain a common sense balance of Efficiency, Capacity and Maintenance. The result is steam produced at the lowest unit cost.

Green Steam Jet Ash Conveyors and Cast-Iron Hoppers provide a clean, quick and economical method of ash removal, transfer and storage.

Green Engineers will be glad to show you how to apply modern factory standards to your boiler room. A letter to Dept. X will incur no obligation on your part and literature covering Green products will be mailed to you.



Green Cast Iron Hopper



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Green Chain Grates

Chain Grate Stokers
Ash Conveyors
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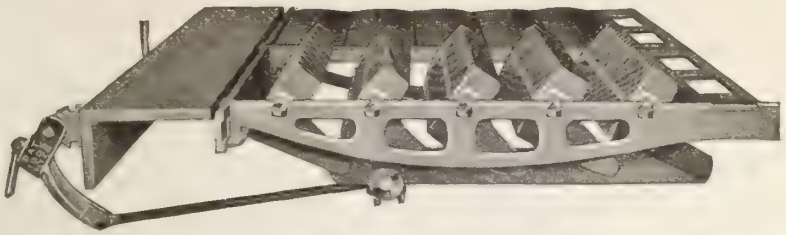
Are You Open to Conviction?

Every progressive business man is usually willing to lend an ear to reason. Consider this:. you can save several tons of coal each month by changing your ordinarily constructed fire grates for Cyclone Grates, and the money you will save through fuel economy will in a reasonably short time pay for the installation.



CYCLONE Grates

The scientific design of Cyclone Grates permits the use of low grade fuel with good results—60% air space, 90% underdraft. The jarring, shaking movement of the grates sifts ALL the ashes through and leaves ALL the good fuel to be burned. No clinkers! No waste!

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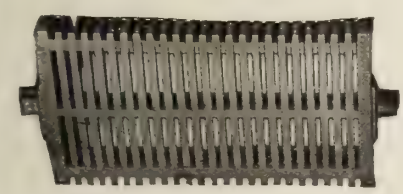
We have decided to sell our grates at the lowest possible price—regardless of any profit to ourselves. This is your opportunity. **Buy now!**



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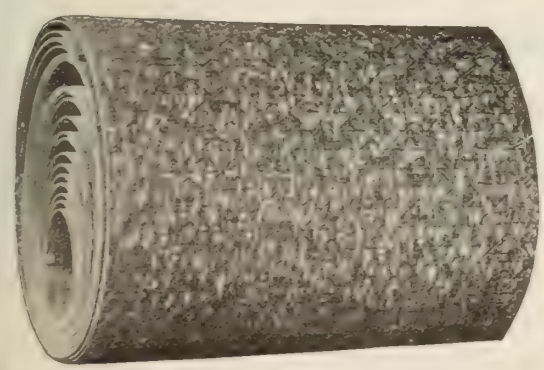

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Simply---Economically Efficiently

Coal is deposited direct on pile

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PROTECT your Company against an inadequate coal supply. GODFREY CONVEYORS will enable you to unload, store and reclaim your coal quickly, simply, economically and efficiently.

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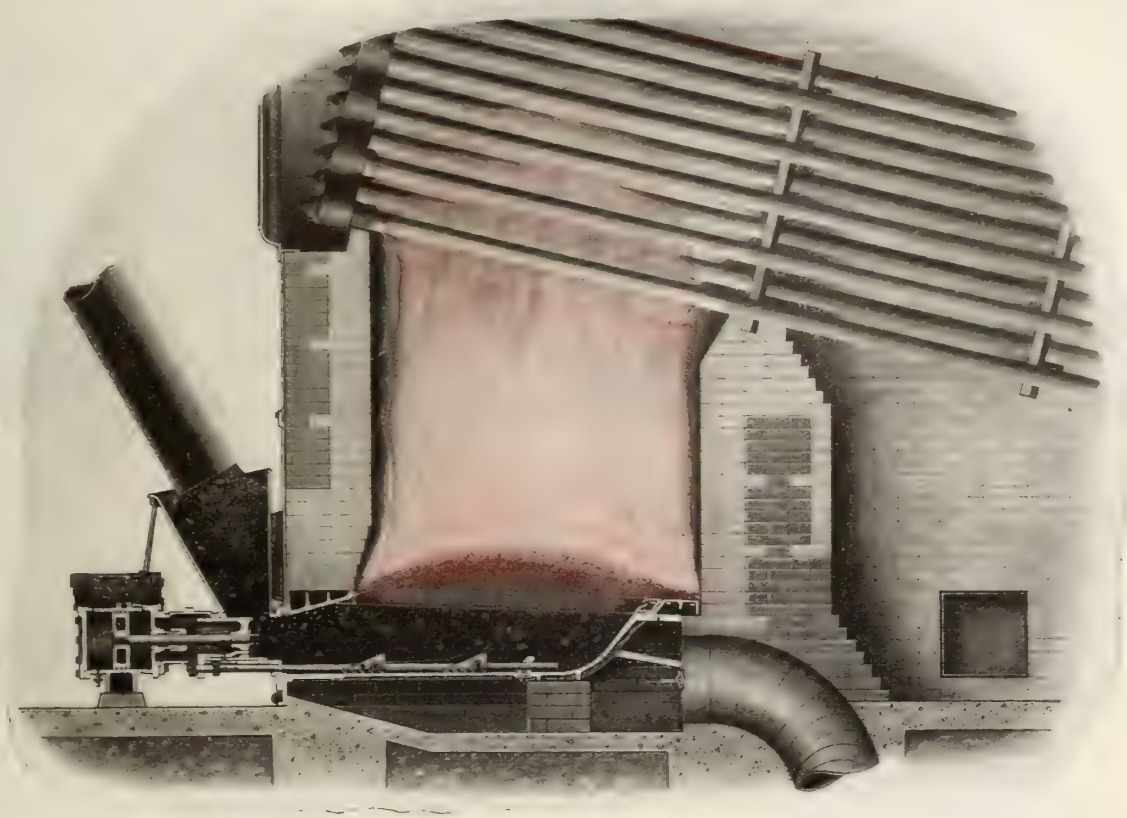

MACLEAN STOKERS

IN EVERY plant where the MacLean Stoker has been installed the result has been a great saving both in labor and fuel. Working automatically, it feeds the fire just the right amount of coal, varying the feed in accordance to varying demands for steam. In this way a constantly uniform steam pressure is maintained regardless of sudden load fluctuations.

The MacLean Stoker burns all classes of bituminous coal. There are no siftings of unburned coal to the ashpit because there are no grates.

The MacLean Stoker is easy to instal—easy to operate—and is adaptable to any kind of boiler plant, large or small. The actual upkeep is negligible owing to simplicity of construction and the fact that no moving parts are in contact with the fire.

May we estimate the saving to be made in your plant? You are under no obligation to purchase.

MacLean Underfeed Stoker Company, Ltd.

95-97 KING STREET EAST, TORONTO, CANADA

Soon Pays the Cost of Installation

"Jenkins Valves Only"

says Pilkington's Chief Engineer

Fig. 106
JENKINS BRASS GLOBE VALVE
Standard Pattern

Knowing valves and valve requirements he prefers Jenkins Diamond-Marked Valves because he has seen them in service, year in, year out —ever dependable and free from trouble.

In big manufacturing plants like that pictured above, dependable valves are all important.

That is why Canada's leading engineers regard the installation of Jenkins Valves as a paying investment. Genuine Jenkins pay for themselves in savings of time, labor and replacement charges.

There's a Jenkins Valve for every requirement of Power Plant, Industrial and Domestic service. The complete line is shown in Catalog No. 8.

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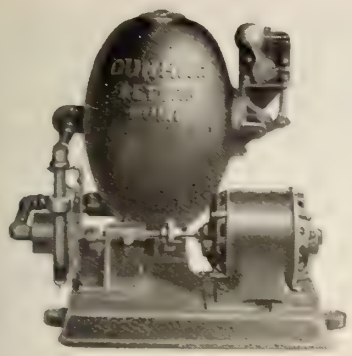

The Dunham Return Pump
Type R. L. P.

HANDLING CONDENSATE With the DUNHAM RETURN PUMP

This new Dunham Return Pump is designed to automatically pump condensate from heating systems, or process work, back to boiler, heater, hot well or other storage. It is an automatic, electric driven, centrifugal pump, stopped and started from a float switch.

The waste of condensate from heating systems where returns are below the boiler water line can be entirely eliminated by the use of the Dunham Return Pump. The condensation from the heating system is returned to the boiler as it accumulates, resulting in improved heating and a saving of fuel.

Dunham Return Pumps are absolutely automatic in action and operate without attention, day or night. There are none of the difficulties caused by low pressure steam pumps when fires are banked for the night.

Full particulars will be sent upon request.

The DUNHAM
REG TRADE-MARK
HEATING SERVICE
(Made in Canada)

C. A. DUNHAM CO., Limited, TORONTO, ONT.

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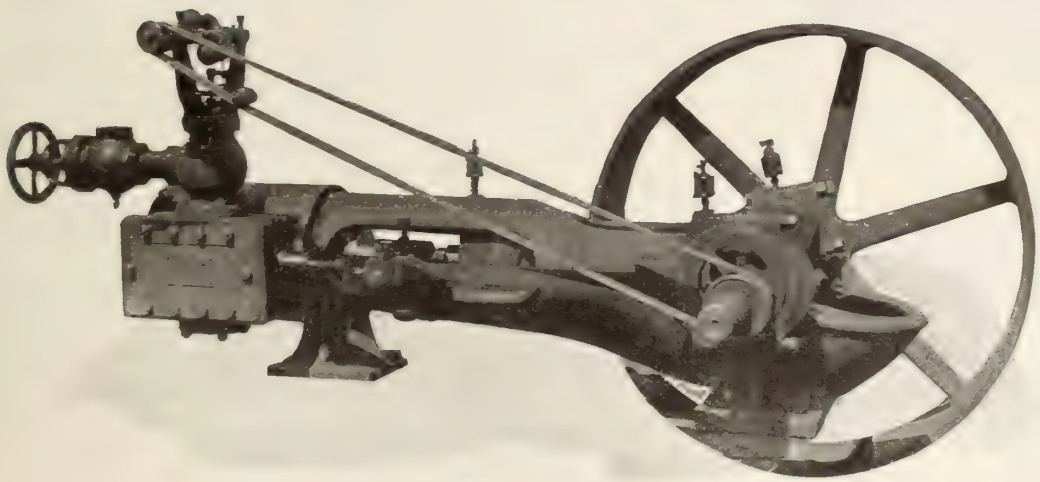

Leonard Clipper Engine

is designed to fill a widespread and growing demand for an engine capable of doing heavy, continuous work with the least amount of care and attention.

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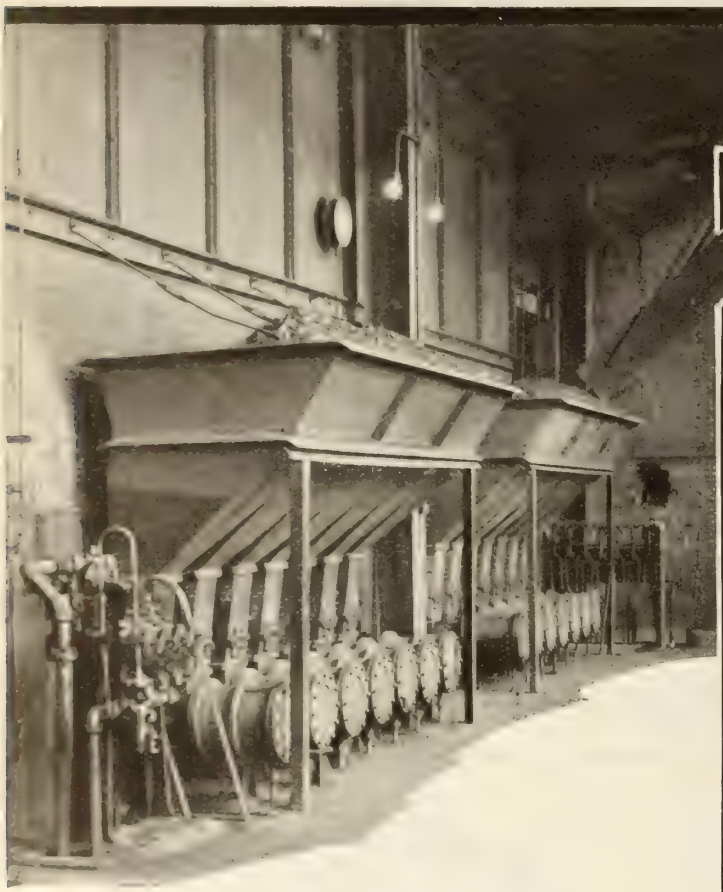
Established 1834

LEONARD

JONES STOKERS



POWER interruptions will not, and should not, be tolerated in modern plants. That is why Jones Stokers are favorites for plants of practically every size. Their rugged simplicity makes shutdowns for repairs next to impossible. Fuel and air are automatically controlled; little attendant labor is required.

In the "A-C" (Automatic-Cleaning) type, fires are automatically cleaned.

Retorts may be individually controlled—an exclusive feature.

Clinkers do not form on bridge or side walls.

The under-feed principle of combustion (originated in Jones Stokers) insures maximum economy of fuel at all loads.

These, and other distinctive features that make the Jones Stoker "pay for itself—then pay dividends," are covered by the new catalog.

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The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. Through special arrangement the extensive engineering resources of the Under-Feed Stoker Co. of America are made available for Canadian power users. Thus this strictly Canadian Stoker is backed by world-wide experience and unequalled engineering ability.

McGowan Duplex

STEAM AND POWER DRIVEN
DURABLE PUMPING EFFICIENT
MACHINERY
PISTON AND PLUNGER TYPE

The Value of Uniformity

The time wasted in changing parts of a pump is an expensive item that does nothing but add to general O.H. charges. This expense is reduced to a minimum in the McGowan Duplex.

These pumps are built to **uniform specifications of the highest standard** with all parts readily interchangeable; in fact, the entire working parts could be replaced in less than an hour, if it were necessary.

Considering the late improvements adapted in our Standard Duplex Steam and Power driven pumps, and the consistent high quality of material and workmanship for which they have long been noted, the price is remarkably low.

We have full line of patterns for direct acting steam pumps and belted or direct connected power pumps.

We shall be pleased to figure on your pumping requirements.

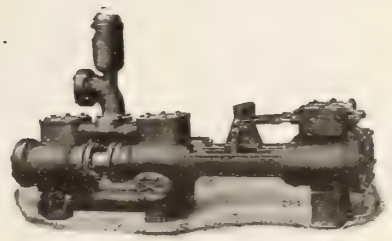

FIG. 7284
Outside Packed Plunger Duplex Steam Pumps, Steam Pumps for all commercial purposes.

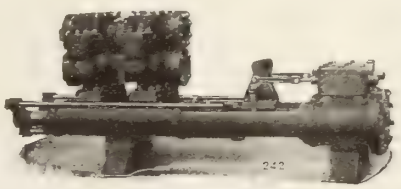

FIG. 7242
Outside Packed Plunger Types up to capacities of 3,500 gallons per minute.

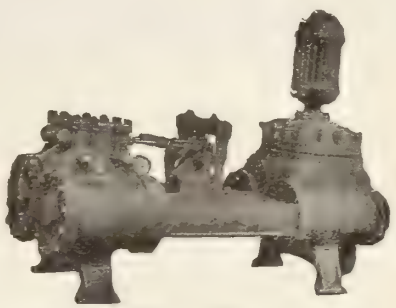

FIG. 7439
Packed Piston General Service Pump.

The John H. McGowan Co.

Cincinnati, Ohio

General Offices and Works - **Cincinnati, Ohio**

Foresight Never Does Any Harm

Look ahead. How long before your factory will be running full tilt? You will never speed up if your belting is in bad shape or if you have to stop for belting repairs.

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Do it NOW while there's Time.

"P. M. S" Belting is made of the toughest and strongest Sea Island cotton fabric, extra heavy, and rubberized to make it non-slip and weather proof. "P. M. S" Belting is proof against Heat, Cold, Wet or Dry conditions.

While your factory is running slack, take the opportunity to go over your machinery with special attention to the Belting.

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CoKal Hopper Feed Chainless Stokers

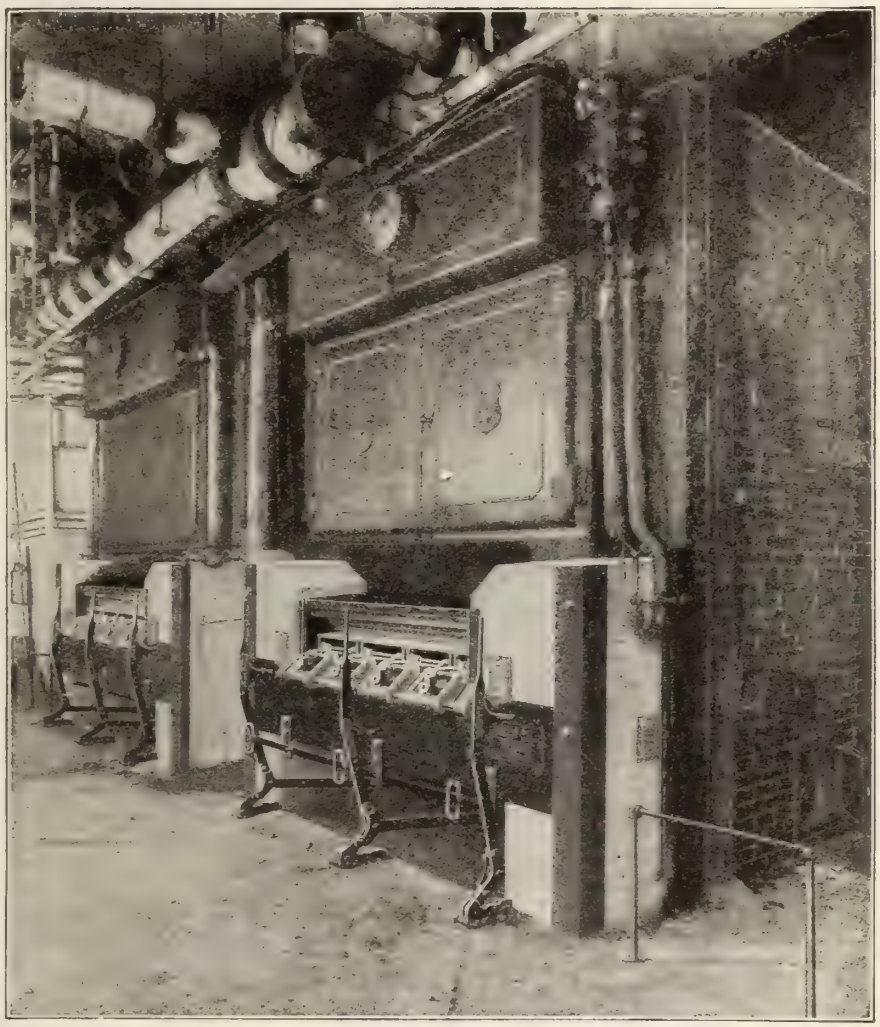
Self Cleaning—Hand Operated

Always Ready for the Peak Load

THE CoKal Hopper Feed Hand Stoker keeps a supply of hot incandescent coke ready for immediate distribution, and permits the recharging of the furnace without opening any fire doors to admit excess air.

Movable feeder blocks control the fuel feed of the hopper, causing the coal to be admitted when and where required. These blocks close the communication between furnace and hopper. They also accelerate the fuel feed when necessary to speed up.

The CoKal Hopper Feed Hand Stoker requires less space for coking, giving more effective stoker area and making it possible to operate at 150% to 300% of rating with suitable draft conditions.



CoKal is Chainless and Crossfeed

A multiple series of intermeshing fingers are so placed as to distribute the fuel both sidewise and lengthwise, closing any holes in the fire and insuring a uniform fuel bed.

Burns cheaper fuel and eliminates smoke. Fires always clean—high efficiency assured. Costs less than automatic stokers and gives the same results. The CoKal stoker is the best hand stoker built. Don't measure hand stokers by the price—rather get dependable performance.

If interested fill in the attached and forward:

We burn.....tons of.....coal annually.

We operate.....hours per day. We have.....boilers.

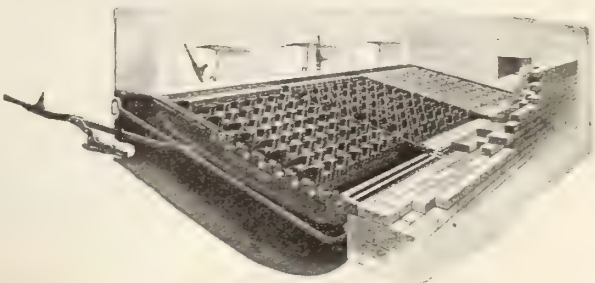
They have.....square feet of grate surface under each boiler. Present grates are.....wide.....long.

We are (not) crowded for boiler capacity.

Name of firm.....

Address . . ..

If you wish representative to call mark.....



CoKal stokers can be furnished with or without hopper feeds.

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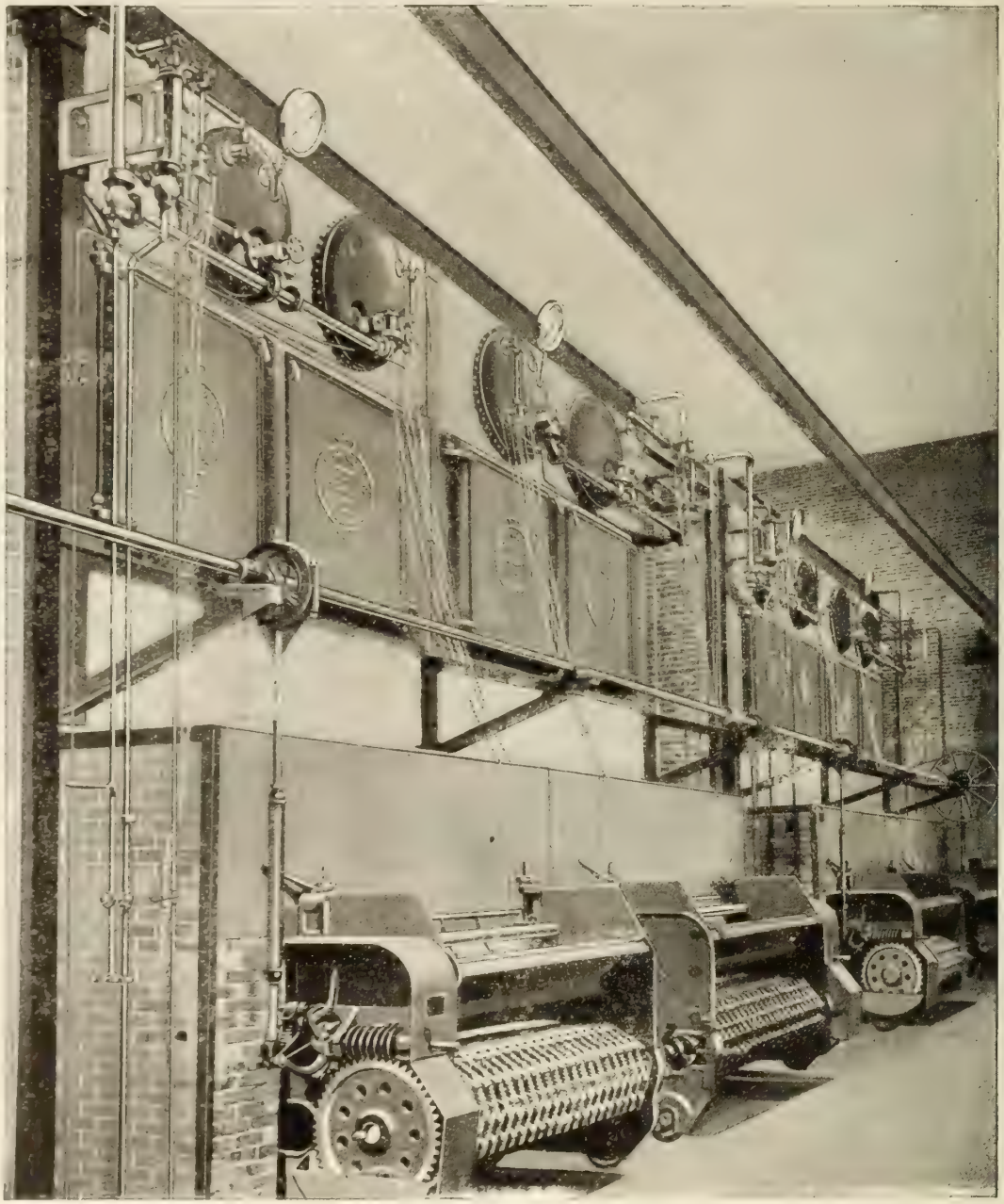

The Boiler Room of the Saskatchewan Provincial Parliament Buildings at Regina equipped with 4 G. & McC. Double Drum Sectional Water Tube Boilers.

These Boilers will give you increased steaming capacity and more rapid circulation. Ask for Catalogues, Prices, etc.

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Members of the Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

The Principal Types of Mechanical Stokers

While the Number of Different Makes of Mechanical Stoker is Legion, They All Conform to One of Three General Types, for the Larger Units. For Small Units Other Types Exist

THERE is no doubt of the general acceptance of the principle of the mechanical stoker, and its manufacture has become practically a special industry. There are a large number of makes on the market, differing in detail, but practically confined to three well-known types.

These are the overfeed, the underfeed and the chain grate stokers. For smaller boilers, up to 200 h.p., there have been developed a variety of stokers, including the sprinkling or throwing types, and those equipped with movable bars for shaking the fire bed, and in some cases dumping the clinks and ash, which are operated by means of levers worked by the firemen. The tendency to-day is to get away from hand stoking whenever possible, even when the change does not effect a saving of labor.

The great objection to hand stoking, even supposing the fireman is a master of his craft, is the necessity for continually opening the fire doors, and the length of time they must be kept open while the fuel is being delivered to the furnace. The doors have to be opened up to lift the fire from the bars and prevent the formation of clinker, and after the lifting has been done, the fuel has to be raked over on the top to preserve its even thickness. Naturally every time these operations are performed, cold air rushes into the furnace, with its accompanying loss of heat, and fuel. There are also sometimes serious mechanical defects induced by the entrance of cold air while the doors are open.

A further drawback to hand firing, is the limitation of the size of grates, that is as far as their length is concerned, for a man cannot handle a fire which is more than from 5½ to 6 feet long, especially when the cleaning time comes. This cleaning of fires is one of the hardest things that a fireman has to contend with, and is at best a long process, attended with inconvenience and loss, and often in a plant that is hard-pushed, a considerable drop in steam pressure results. With mechanical stokers all these disabilities are removed and a means provided by which coal can be fed at practically any required rate, and with the help of forced draft, burned at high rates per square foot of grate surface per hour, with much higher efficiency than is possible under hand conditions. It is of course quite possible to have very low efficiency with mechanical stokers if they are not properly regulated, and to this extent they require the guidance of human brains. Given this modicum of attention, they will deliver the goods both from the point of view of high rating and high efficiency of combustion.

Choice of Stoker

The question of whether to use mechanical stokers or hand firing is settled at once by the size of the boiler installation. For anything under 200 h. p. it becomes a question of very careful figuring to determine whether the investment will be justified by the saving in fuel, because it must be remembered that there can be no labor saving on a small installation. However, as mentioned before, for this type of plant, there is available the type of stoker that can be installed at low cost, such as the sprinkler, or one of the various types of moving, or moving and dumping grate bars. These will justify themselves on the ground of fuel saved, even if there is no labor saving. In cases where the total installation may be as much as 600 to 700 h. p., but the units of small size, as in the case of the horizontal boiler, these semi-automatic types are useful.

When it is a large plant, or a plant with large units, the choice of type of stoker will be governed by the kind of fuel available, and the rating to be developed by the boiler. Where the load is of a steady nature, and the boilers are to be operated at about their normal rating, a natural draught stoker is probably the most suitable. If the fuel is of a high volatile character, the chain grate stoker would be the best to use. Where high ratings are to be encountered, for varying periods, or where the boilers are to be run overrating all the time, a forced draft installation is indicated. For burning such fuels as anthracite slack in the very small grades available a chain grate stoker is very suitable. For bituminous coals with a moderate amount of volatile content, and high in fixed carbon a stoker of either underfeed or overfeed operation can be used. It is difficult to say definitely where the usefulness of one type ends and another begins, because lately all types of stokers have been adapted to burning all kinds of fuel. For instance, wood mill refuse has been burnt with very good results in conjunction with coal on underfeed stokers, and such fuel as tanbark with a high degree of moisture has been handled successfully on overfeed stokers. Western lignite, which is a low grade fuel, has been burnt and is being burnt on chain grate stokers.

Chain Grate Stokers

The chain grate consists essentially of a flexible steel chain conveyor, fixed on rollers at front and back of furnace, and driven by a small engine or motor through suitable gearing. The speed of the grate is made variable, either through a variable speed motor on the drive shaft, or a series of change gears on the stoker shaft itself. This variation of speed in the grate is accompanied by a variation of rate of combustion of the coal.

The fuel is fed from the containing hopper through a gate which in some cases has a fixed opening, and in others a variable opening to the grate. In order to produce ignition rapidly, an arch faced with a refractory brick is suspended over the grate, covering the part of the furnace which is outside the setting of the boiler. This refractory ensures the volatile gasses being thoroughly ignited and combustion carried out before the cooler surfaces of the tubes or boiler shell are met with, and the arch is usually known as the ignition arch on this account. The grate traveling along carries the burning carbon slowly under the reheating surfaces, and when the back of the furnace is reached there is nothing remaining but the incombustible. As the chain turns around over the back roller on its completion of the revolution, the unburnt residue is precipitated into the ashpit.

This point at the back end of the furnace has to be carefully designed so as to leave no space by which excess air could be drawn in over the grate. In some designs what is known as a water

back is fitted, this being a hollow casting through which the boiler water circulates. As the fuel is brought along by the grate to the end it is pressed against this water back. This compresses the top layer of the fuel while leaving a space for the ash to drop underneath, and thus makes an air seal. The water back also prevents the clinker adhering as it would to a hot brick face.

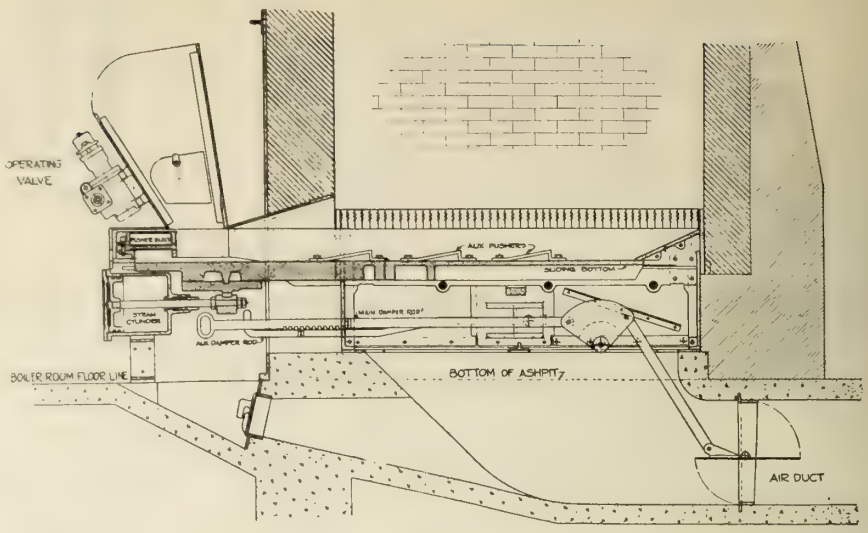
The action of the chain grate may be classified as progressive combustion, the volatile gases being first distilled and ignited by the heat of ignition arch, the air coming through the grate from underneath supplying the necessary oxygen to give complete combustion of the volatile matter and the solid carbon remaining on the grate. Rate of combustion can be varied by varying the speed of travel of the grate, which automatically increases the rate of combustion per square foot per hour.

We illustrate a number of the different types of chain grate stoker.

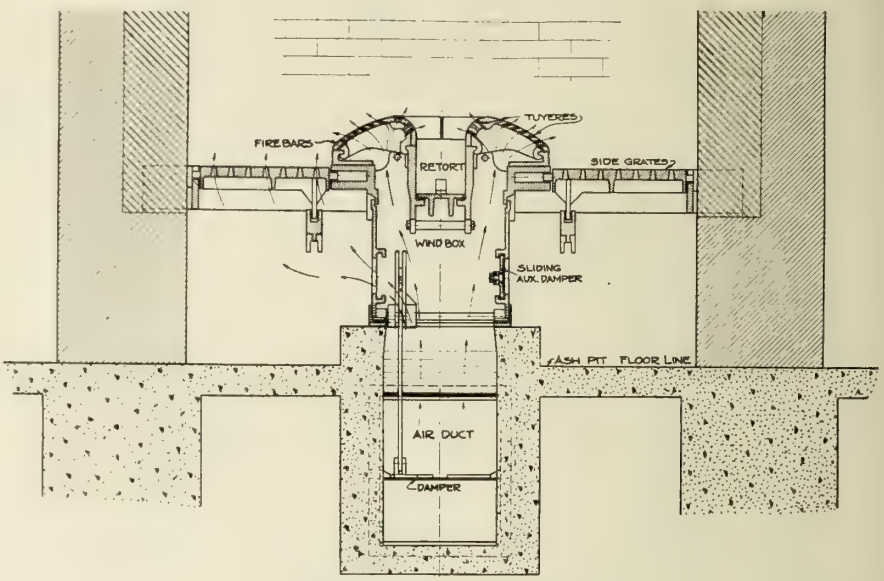
The Underfeed Stoker

The underfeed stoker is in general a forced draft arrangement, the fuel in this type of stoker being in a very thick mass, through which the air for combustion must be forced. The usual arrangement is a trough in a ram moved backward and forward by means of a piston contained in a cylinder outside the boiler setting. On top of this cylinder and directly communicating with the trough is the coal hopper. The action of the stoker is to push the charge of green coal into the bottom of the retort, underneath the glowing coal on the top of the retort. The volatile gases are immediately distilled from the green coal and passing up through the glowing bed above are thoroughly ignited and complete their combustion as they pass under the heating surface. The solid carbon is ignited and in turn pushed up to the top of the retort by the fresh incoming charge of coal. The ash and clinker fall onto the side plates and are gradually worked along to the back of the furnace and dumped into the ashpit, or in some cases are drawn out through the furnace doors by hand. Air is supplied through tuyeres at the side of the retort.

Quite a large number of different makes of the underfeed stoker are available, but they differ mostly in detail. The principle of underfeed stoking is that the green coal is placed directly on to the grate underneath the mass of incandescent carbon, instead of being thrown on top of the burning coal as in ordinary firing. In this way a chain grate can really be considered as an underfeed stoker, although the name is usually reserved for the type of stoker which has a ram for pushing the green coal onto the bed and under the burning coal above.



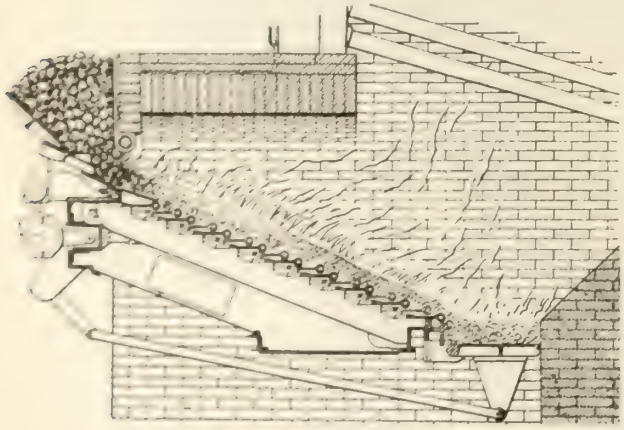
Longitudinal Section Type K Stoker



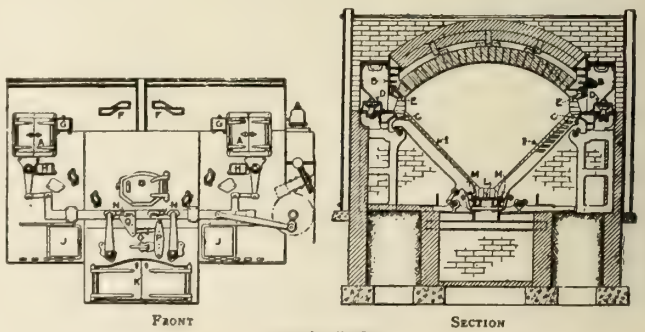
Cross Section of Type K Stoker

Overfeed Stokers

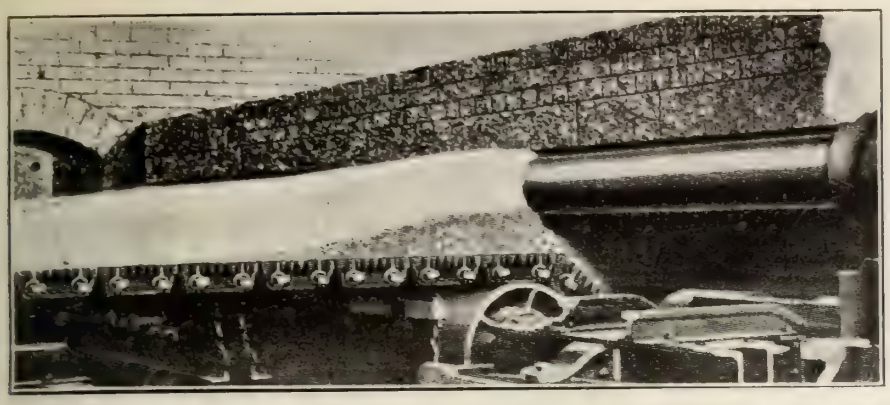
In the overfeed type of stoker, the grate is set at an angle of about 60 degrees forming a V shaped furnace. Over suspended an arch of refractory material, or faced with refractory material. Fuel is fed into the grate through openings at the side and top of the grate. Air is supplied through openings in the arch and also through the lower part of the grates. Slight movement of the inclined bars and the force of gravity cause the coal to travel from the top to



Lehigh Stoker For Forced Draught



Detroit Stoker



Green Chain Grate Showing Waterback

the bottom during the process of combustion, and in the bottom of the V there is usually an arrangement for breaking the clinker and enabling it to be dumped into the ashpit underneath. The coal as it is fed onto the grate at the top comes under the influence of the refractory and the volatile gases are distilled off and ignited, the remaining solid combustible passing slowly down the grate until it reaches the bottom as incombustible.

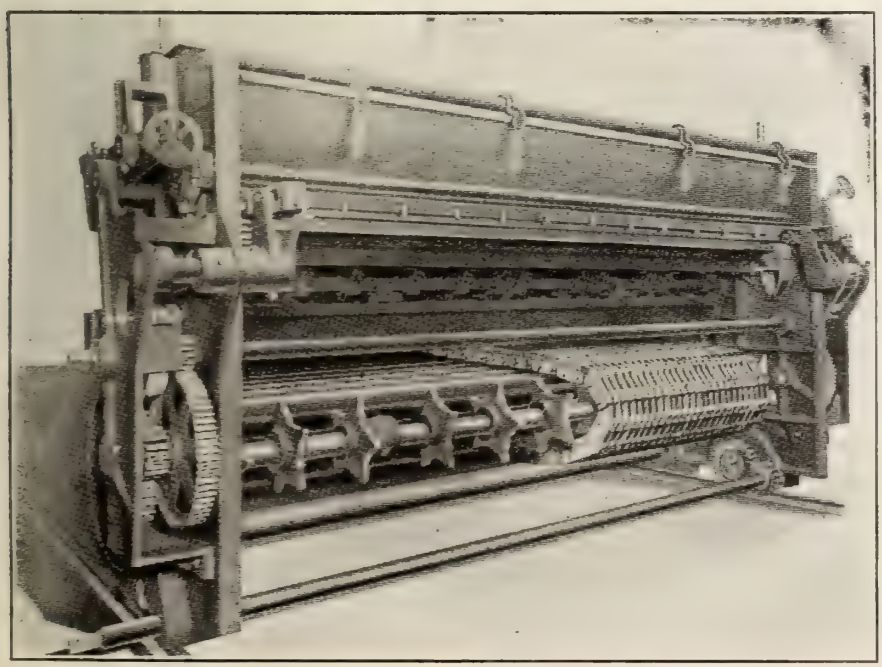
Work of Manufacturers

To the stoker manufacturers in general, engineers owe a pretty considerable debt. They have in the course of their investigations cleared up many points in the science of combustion of fuel under boilers that were not clear. They have materially aided the conservation of natural resources by continually striving to promote more efficient combustion. The continued success in developing efficient stokers has spurred on the manufacturers of refractories to produce a setting that will stand up under the high temperatures now produced in furnaces. The mechanical stoker has made possible the large boiler unit and the high over ratings which enable a plant to operate under excessive loads with a normal investment in boiler plant.

The Stoker Manufacturers Association which includes the manufacturers of all the better known types of stoker, are doing a good work by collaborating together in research and sharing experiences, all of which is to the general good of the steam engineering world.

BRITISH ELECTRICAL RESEARCH

While an increasing amount of electrical research work continues to be done by individual electrical engineering firms in Great Britain, co operative research is being developed on an ambitious scale. The Research Association formed by the British Electrical and Allied Manufacturers is expending £8,000 a year for 5 years on this type of research, which is aimed at the benefit of all concerned in the electrical industry. This financial arrangement was made at a time of acute depression in the world's trade and it will probably be greatly bettered when conditions improve. While this sum in itself may not appear large, British research workers have the faculty of getting very valuable results from a very moderate expenditure. The Royal Institution of Great Britain, in which Humphrey Davy, Faraday, Dowar and other famous scientists made their valuable discoveries, did not expend much more than £100,000 on research over a period of 100 years. Practically every leading section of industry in Great Britain has its organised co-operative research association. In the case of brass, copper, and other metals not containing iron, a great deal of very interesting research is now being carried on. The casting of brass, the influence of impurities on the working of copper, the electric melting of non-ferrous metals, and the grinding, jointing, and polishing of such metals are being closely studied. Perhaps the most important part of this research lies in the investigation of corrosion. The production of rustless iron and steel has stimulated the brass and other industries to give attention to the causes of corrosion. It is stated that the examination of tarnishing, which is the first stage towards corrosion, has already yielded very interesting results.



Green Chain Grate Showing Driving Mechanism.

BURNING BROWN COAL

Valuable deposits of brown coal and lignite are found in various parts of the world, and a great deal of scientific attention is being given to the problem of utilising them to the best advantage. In no other country have the problems of economical fuel consumption been more successfully studied than in Great Britain; and it is only natural that British engineering firms should have recently devised special boilers and furnaces for the efficient burning of brown coal. A trial installation in which the usual arrangements for burning ordinary coal were ingeniously modified, was set up recently in a British factory and exhaustively tested with very promising results. The object of the apparatus is to improve or raise the grade of the coal before it is actually fed on to the grate. The fuel passes through a special apparatus for a period of 45 minutes, during which it is exposed to hot gases which drive off the greater part of the moisture and the carbon dioxide. The result is a fuel of a much greater steam producing value than the original coal.

The Combustion Equipment Co., Kent Building, have been appointed agents for the Graver type K water softener, a product of the Graver corporation, East Chicago, Ind.

A 20-page booklet has been published by the Hydraulic Society, New York, entitled "Trade Standards in the Pump Industry." This work explains what is meant by trade pumps. plain fitted pumps, or brass fitted pumps; what is considered standard equipment for trade pump and what are considered extras; typical sizes of trade pumps are shown and definitions are given of terms used in the industry such as static head, total dynamic head, static suction lift, dynamic suction lift, etc. The booklet is recommended by the society as a guide to pump users.

Underfeed Stokers In Harvester Plant

Steam is Used for Both Power and Process Work in This Hamilton Plant. The Coal Handling, Storage and Ash Disposal Arrangements Are Well Designed and Convenient

THE FOLLOWING description of recent additions to the power house equipment of the International Harvester Company of Canada at their Hamilton works, will no doubt prove to be of interest.

The power plant at present in use was erected in 1912 and at its inception was used as an auxiliary plant, ample provision being made, however, for additional equipment necessary at such time as the old power house was discontinued, also to take care of future expansion.

During the past year additional steam generating equipment has been installed and at the same time an endeavor has been made to bring the coal and ash handling system thoroughly up to-date.

Having in mind the rapid progress made in power house equipment during the past few years, no attempt will be made to describe the equipment in detail with the exception of that which has been recently installed.

The power plant, centrally located east and west, is situated towards the south end of the property, the natural course of any future expansion being in this direction. It consists primarily of an engine room and boiler room and has overall dimensions of 105 ft. x 105 ft. It is of steel and concrete construction with the exterior walls of pressed brick trimmed with stone and whilst of pleasing appearance, utility has been the keynote of its construction. The transformer room, accessible from the engine room, is a separate structure. The pump room is in the basement under the engine room. In the boiler room, steel stairways and galleries give ready access to all pipe lines, boiler tops and the overhead bunker, coal conveying and distribution equipment.

Original Equipment

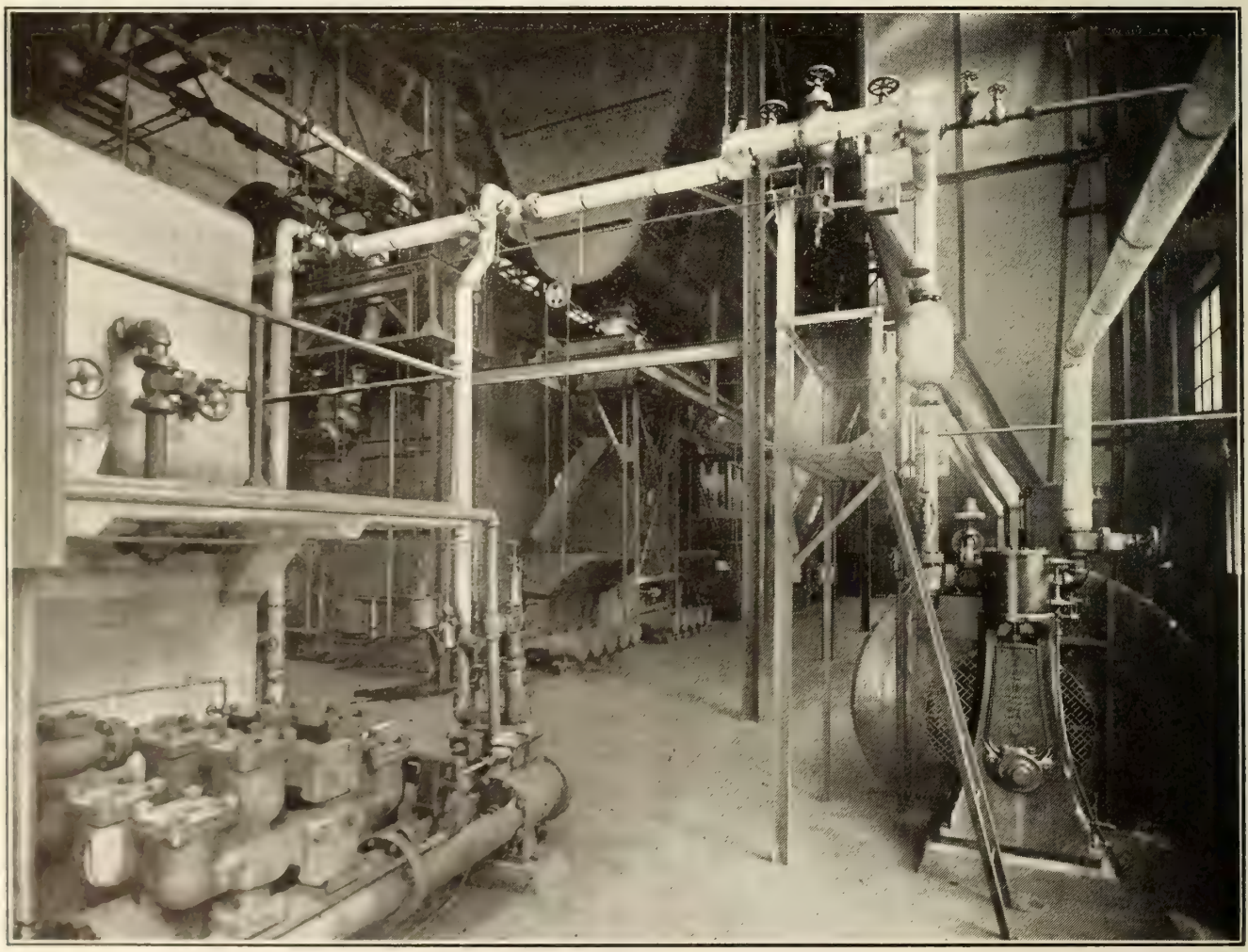
The initial steam generating equipment consisted of two type 30 Stirling boilers, each with a heating surface of 4000 sq. ft., 420 3¼ in. tubes and 7 in. steam outlets. These units are equipped with B. & W. cored type superheaters and Dutch ovens with grate areas per boiler of 89 sq. ft. and are designed to burn both coal and wood refuse from the wood shop, have a working pressure of 150 lbs. gage and a nominal rating of 400 h. p.

Electric energy can be generated when occasion requires but normally the steam generated is used for heating, the operation of air compressors, steam hammers, the heating of water for domestic purposes and the operation of many pieces of auxiliary apparatus installed in and about the power house.

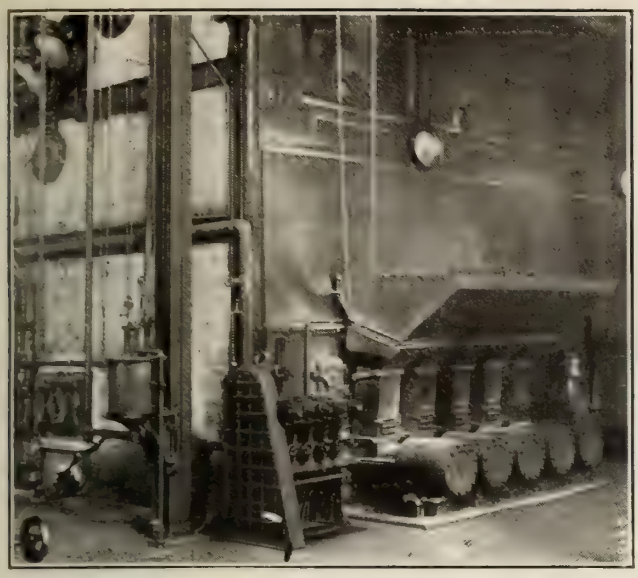
An auxiliary steam generating unit is provided by means of a Wickes waste heat boiler, of a nominal horse power of 400, in connection with the malleable foundry.

Coal Storage

The coal storage area is situated on the east side of the power house, the unloading and reclaiming of the coal be-



General view showing boiler room arrangement.



Showing Stoker control and five retort stoker and damper regulator.

Front view of stoker installed by Underfeed Stoker Co. of Canada.

ing taken care of by a traveling electrically operated Shaw crane, operating a clam shell bucket, the crane is of 3 tons capacity and has a span of 75 feet and a length of 250 feet.

Cars delivering the coal are run over a reinforced concrete dumping pit, and there emptied, the pit having a capacity of two cars, the coal may then either be delivered to the bunker or to the storage area. The plant locomotive also obtains its supply of fuel from this source. A fence 6 ft. high has been constructed around the storage area and by this means all coal in storage is kept within the range of the crane and no trimming is necessary.

The capacity of the area available for coal storage is about 4,500 tons all readily accessible to the clamshell bucket operated by the crane.

At the western extremity of the coal storage area is situated the coal crusher and conveying equipment. A steel hopper 10 ft. x 10 ft. in plan delivers the coal to a reciprocating plate feeder, which in turn feeds a single roll crusher 30 in. x 30 in. The plate feeder is driven by chain and sprockets from the crusher roll shaft. The crusher operates at a roll speed of 50 r. p. m. and is driven by a 30 h. p. motor. The outlet from the crusher discharges upon an apron conveyor 33 ft. in length operating at a speed of 100 f. p. m. and like the plate feeder is driven from the roll shaft of the crusher. The apron conveyor discharges into the boot of a centrifugal discharge elevator. This elevator is on 39 ft. centres, operates at a speed of 200 f. p. m. and is made up of 14 in. x 7 in. steel buckets spaced 24 in. on centres, this elevator in turn discharges into a spiral conveyor; this conveyor is 86 ft. in length and runs the length of the boiler fronts, being suspended to the upper members of the roof trusses, the spiral is 12 in. in diameter and operates at a speed of 75 r. p. m., suitable outlets are provided for filling the coal bunker. The capacity of this equipment is 25 tons per hour.

The overhead coal bunker is of steel and of 100 tons capacity and is situated directly across the fronts of the coal burning boilers; a traveling weigh lorry having a capacity of 1500 lbs. runs directly beneath the bunker and is used to weigh and deliver the coal to the stoker hoppers. Should it be desired to feed coal to the wood refuse burning boilers this can be readily obtained from the weigh lorry by means of a portable chute on wheels so that the only hand labor is that occasioned in feeding the coal to these furnaces.

The New Plant

The new steam generating equipment consists of two Stirling water tube boilers, type S 21, each with a heating surface of 4135 sq. ft., 8 in. steam outlets and B. & W. cored type superheaters.

These units are equipped with 5 retort Jones A. C. underfeed automatic cleaning stokers with active grate areas per boiler of 80.1 sq. ft. and a capacity of 2,200 lbs. of coal per hour at 150 per cent. capacity; have a nominal rating of 413 h. p. and are designed and constructed for a working pressure of 150 lbs. gage. A brief description of the stoker automatic control follows:

The coal is forced into the furnace below the live fire bed by steam operated rams whose actions are governed by a special valve known as the Cole automatic valve; which allows of individual control, either automatic or by hand, of the feed to each retort, these retorts being spaced 20 inches on centres across the width of the furnace. The setting of the valves, which is done by hand, adjusts the number of strokes of each ram in relation to a fixed speed of the worm drive actuating the valves. The speed of this worm drive, which is belt driven from the shaft of the forced draft fan, is therefore governed by the speed of the fan engine which is in turn automatically controlled by a fan engine regulator according to the variations in the steam pressure.

In this way the cycle is complete, any reduction in steam pressure increases the speed of the fan engine, thereby increasing the quantity of air delivered to the furnace and at the same time increasing the quantity of coal fed to the furnace. This condition exists until the loss of pressure is made up, when normal operation automatically ensues.

In the furnace the coal is forced upward and backward during the process of combustion until it reaches the balanced dump plate at the rear of the furnace, in the form of ash and clinker, and at this point the automatic control ceases.

From the dump plate the furnace refuse is dumped into the ash pit, accessible from the basement, sprayed from a pipe line situated immediately below the dump plate and allowed to cool.

The forced draft employed in connection with the stokers for these boilers is supplied by one extra heavy steel plate blower, capable of delivering 30,000 cu. ft. of air per minute when driven at a speed of 440 r. p. m. by a 9 in. x 8 in. vertical self oiling steam engine. This fan which is under automatic steam control, discharges into a concrete duct having a sectional area of approximately 12.5 sq. ft. and thence into a metal duct connecting with the air chambers under the stokers. The static pressure is 4 inches of water.

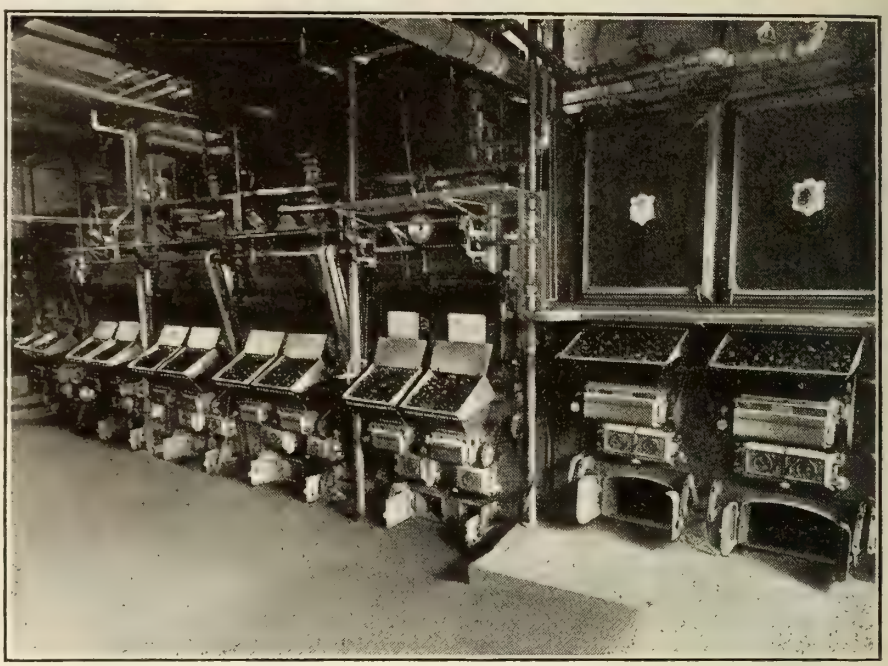
Control of the furnace draft through manipulation of the stack damper is effected by means of a hydraulically operated damper regulator. The control exerted by this regulator depends entirely upon the amount of negative pressure or vacuum existing in the furnace itself and not on the variations in the steam pressure. Consequently there is a positive movement of the damper in direct relation to the needs of the furnace for

(Continued on Page 25)

Sprinkler Stokers In a Mill Power Plant

A Type of Stoker Readily Adaptable to Any Boiler, Requiring no Alterations of Furnace Brickwork or Ashpits. A Thin Even Fuel Bed is Attained by the Action of the Revolving Blades

IN DISCUSSING the various styles of stoker in another article in this issue, the sprinkler type is referred to as being of a nature suitable for small installations, on account of its moderate cost. This makes it possible to instal a mechanical stoker in a plant which perhaps could not be made to show a profit on the installation of a stoker requiring special brickwork setting and arches. The sprinkler stoker, referred to in this article, does not require any special setting, and can be readily applied to any type of boiler without structural alterations being necessary.

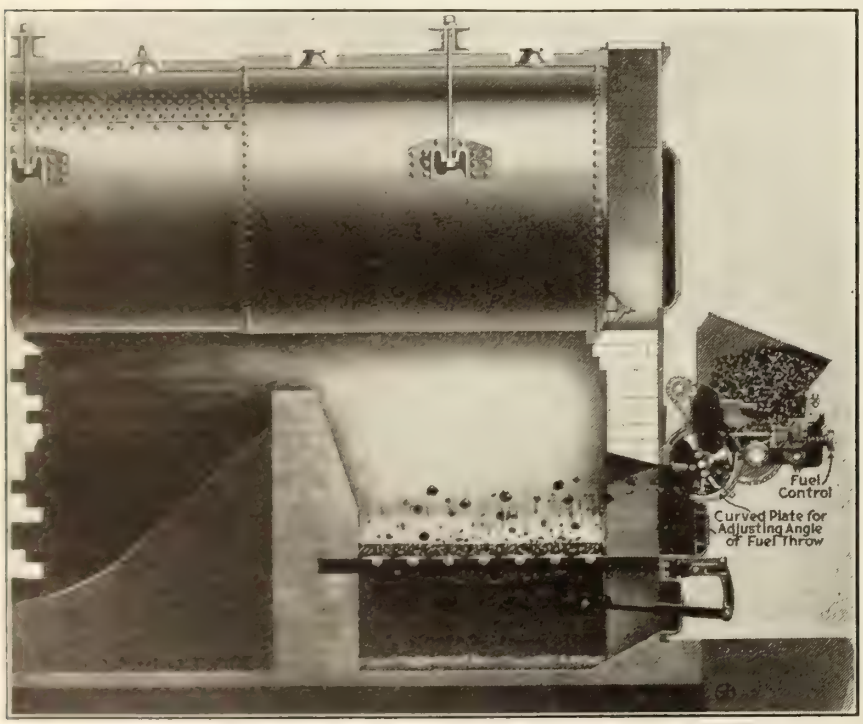


Installation at Western Canada Flour Mills.

Constructional Features

The "Canada" stoker, manufactured by the Canada Stoker Co., Galt., consists essentially of a hopper containing a reciprocating feed plate actuated by an eccentric. The coal in the hopper works down due to the motion of this feed plate, until it reaches a flat plate or table, formed as an integral part of the stoker. In front of this table are a set of revolving blades, driven by the stoker mechanism, which catch the coal as it is pushed along the table, and due to their motion, fling it out over the surface of the grate in an evenly distributed stream. The feed plate has a catch which enables it to be stopped and started at will. The revolving blades have only to throw the coal that reaches them, the feed being regulated entirely by the feed plate.

The illustration makes the manner of distribution clear. There are one or two points which cannot be shown in an illustration of this kind. For instance, there is a curved plate concentric with the blades, and open on the side next to the furnace. This plate can be moved on its centre so as to bring the opening to the furnace either higher or lower, and in this manner give an adjustment which determines the longitudinal distance which the coal will be thrown. The curvature of the blades is such that the width of the furnace is effectually covered. The result of feeding the coal in this manner is to keep a bed of coal of about the ideal thickness, that is four inches, and furthermore it keeps it absolutely level. The absence of holes and hillocks in the fire, in conjunction with the ability to maintain a very light fuel bed, is a requisite of efficient combustion.



Side view showing action of stoker.

In order that there shall be no damage to the revolving blades which have a speed of about 270 revolutions per minute, in case of some obstacle such as a large lump of coal getting into the stoker, a safety feature is incorporated. The blades are held in their radial positin by the centrifugal force due to the speed of revolution only. In case of a solid obstacle to their progress being met, the blades simply swing back on their pivots, thus saving the possibility of a broken blade, and stoppage of the stoker.

There are usually two hoppers to each furnace which practically divides the stoker into two units. This feature is very useful when cleaning fires, as it enables this operation to be performed with speed and ease. The usual plan which has been found best, is to disengage the feed latch on the side. This immediately stops the supply of fuel to one side of the grates, and this side automatically burns down. At the same

time a little fuel is placed on the dead plate, and as soon as this is ignited, the burnt down side can be dumped, the live coal pushed onto the bars, and the feed latch replaced. This is all that is necessary and the process is then repeated for the other side. It is claimed that the entire operation can be performed in four minutes.

An Interesting Installation

Our readers will remember in the Nov. 5th, 1920, issue of "Power House," there was a description of the plant of a flour mill, which had as a by-product the manufacture of salt. The plant alluded to is the Western Canada Flour Mills and at the time of writing the article the boilers were equipped with dumping bars. There are in this plant five Heine boilers and one B & W boiler, as can be seen in the illustration. These boilers have since the article was written been equipped with the Canada stoker, with very good results. The boilers under hand-firing conditions had to be run all the time in order to supply the demand for steam. With the stokers, and their greater capacity and flexibility it has been found possible to use a cheaper quality of coal, and to shut down two boilers for ordinary running.

This is a case where the units were of small size, three of the Heine boilers being of only 100 h. p., two others being of 125 h. p., while the B & W boiler is 306 h. p.

It can be readily seen that to instal, either an underfeed, chain grate or overfeed type of stoker would have entailed structural alterations of the boiler settings which would have made the cost of installation extremely high, and apart from the cost, the location of the boilers was such that the installation of any of these types would have been difficult.

A stoker of the nature of these fitted lends itself particularly to a job of this kind. This installation is a good illustration of finding the particular type of stoker to suit the local conditions. There are other conditions which would call for a different type, but the main point is that nowadays owing to the enterprise of stoker manufacturers, there is practically a type of stoker for every condition that arises and that can be installed at a first cost which makes it a profitable investment, whether the plant be of the order of 50,000 h. p. or 200 h. p.

HARVEST PLANT

(Continued from Page 23)

greater or less draft as dictated by the furnace condition itself.

As was mentioned previously, ash and other furnace residue as discharged by the stoker grates is collected in the ash pits which are accessible from the basement. The capacity of these ash pits are sufficient for at least 24 hours normal run, so that once daily suffices for their removal. They are removed in a small dump car propelled by hand and dumped into the skip hoist bucket. The distance from the ash pits to the skip hoist dump is approximately 30 ft. The skip hoist elevates the ashes 50 ft. and discharges them into a chute which in turn discharges into the concrete ash hopper. The skip bucket has a capacity of 1 cu. yd. of ashes and is operated by an electric hoist driven by a 7½ h. p. motor.

This equipment functions as a single cycle skip, starting from the bottom it travels to the upper position, stops, and after a time interval comes down to its original position and remains in this position until such time as the operator requires to start it.

The ash hopper, situated on the south side of the power house is of reinforced concrete. It has a capacity of about 75 cu. yds., is elevated above the railroad track and can be emptied either direct into the cars or dump wagons as occasion may demand. A portable chute has been provided to enable dump wagons to draw along side and receive their loads.

As the ashes when delivered to the hopper contain considerable moisture, heat has been provided within the hopper to be used during the winter to prevent the ashes from freezing.

The outstanding and perhaps somewhat unusual feature of this work is the manner in which it has been executed. From its inception to its completion the job has been handled by the company's own engineering and construction department and it is a concrete example of the self sustaining qualities of a modern industrial plant.

STOKER MANUFACTURERS' ASSOCIATION

Organized August 1, 1918

AN ASSOCIATION formed for the following objects:

The discussion of subjects of interest and value to the industry in which its members are engaged.

The advancement and improvement of that industry.

The standardization of manufacture and application.

The promotion of a spirit of co-operation among its members for the improved production and increased application of stokers.

The association aims to elevate the stoker industry to a high plane, its purpose being both ethical and practical.

A reputation for honest product, honorable business dealings and service to the public is a pre-requisite for membership in the Association. The emblem of the Association may therefore be regarded as an assurance of satisfactory business dealings with any member entitled to use it.

Membership.

American Engineering Company, Philadelphia, Pa.; Babcock & Wilcox Company, New York City; Burke Furnace Company, Chicago, Ill.; Combustion Engineering Corporation, New York City; Detroit Stoker Company, Detroit, Mich.; Green Engineering Company, East Chicago, Ind.; Illinois Stoker Company, Alton, Ill.; James A. Brady Foundry Company, Chicago, Ill.; Joseph H. Roach & Company, Inc., Philadelphia, Pa.; Laclede Christy Company, St. Louis, Mo.; Murphy Iron Works, Detroit, Mich.; Sanford Riley Stoker Company, Worcester, Mass.; Underfeed Stoker Company of America, Detroit, Mich.; Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa. Joseph G. Worker, secretary, Stoker Manufacturers' Association, Eau Claire, Wisconsin.

Annual Meeting Date.

The Executive Committee have decided to hold the Annual Meeting at the Griswold Hotel, Eastern Point, New London, Conn., June 19, 20 and 21.

Make your reservation direct. This is a wonderful place. There will be boating, bathing, golf, dancing, side-trips, etc., so do not fail to make arrangements to be there. The New York Booking Office for the Griswold Hotel will be opened at the Hotel Biltmore, New York City, about April 15th so that members will be able to get accommodations by writing to this address about June 18th, which is just the time that we will have our meeting there.

A REMOTE IRON FOUNDRY

The island of South Georgia, where Sir Ernest Shackleton has been buried, is 2,000 miles from civilisation; but it is shortly to possess a complete, though small, iron foundry. A British firm has despatched to this distant isle one of its special comprehensive plants for making castings required in repairing the machinery of whaling vessels. Any necessary repairs to the ships can also becarried out by this equipment.

CLEANING OILY MACHINE PARTS

One of the most troublesome of the minor problems in the repair and overhauling of motor cars and other machinery is the perfect cleaning of parts which have been thoroughly soaked in oil. This problem is very ingeniously handled in the new central repair works in connection with London's great motor omnibus service. The parts to be cleaned are placed on wire trays mounted on a conveyor which moves very slowly through a cylindrical casing inside which are mounted on a number of pipes perforated with holes ⅛ of an inch in diameter. Hot caustic solution is forced through the pipes by a pump, and the multitude of jets reach every part of the gear wheels and other portions of machinery passing through. When the parts emerge from the cylinder they are practically free from oil. In this way a process which generally is most prolonged and laborious is perfectly carried out in a minute or two.

Mill scale and adverse weather conditions promote corrosion of steel. Mill scale and all rust must be removed before any paint is designed to protect the clean steel surface. The second coat of paint protects the first coat from the weather and this second coat must, therefore, be impervious to moisture and frost.

Hand Operated Stokers For The Small Unit

The Stoker Described and Illustrated in This Article Has Been Installed in a Number of Canadian Industrial Plants—It Can be Equipped With Mechanical Feed if Conditions Require it

AN NTERESTING example of the type of stoker that may be termed semi-automatic, in that it is intended for hand operation of the grates themselves, is the Files Stoker which is made in Canada by the Waterous Engine Co., Brantford.

The stoker is designed to get away from the disadvantages attendant on hand firing and cleaning, and at the same time be adaptable for small units. It is easily attached to any boiler, the only work to be done on the boiler fronts being the drilling of a few holes to support the lever brackets, which are set at the front of the boiler.

Stoker Operation

The grate is inclined to the back of the boiler, and the coal which is fed onto the front bars, is there coked, the volatile gases passing over the incandescent fuel bed, where complete combustion takes place. The coked coal is gradually worked down the inclined surface by the operation of the stoker bar handles, which are situated at the boiler front. The operation of the handles turn the stoker's bars up into the fire about six inches, breaking up the clinker and ash, and pushing it forward to the cleaning plate, while the coked fuel is also advanced along the inclined bars. There is thus a free passage for air through the fuel bed constantly maintained.

The cleaning plate at the lower end of the grate is counterbalanced, and a single pull on the lever is sufficient to dump the ash and clinker into the ashpit, without the loss of any unburned coal, and with absolutely no waste of time, therefore no drop in pressure.

The illustration of the operation of the stoker gives a very clear idea of the processes. Figure 1 shows the normal condition of the fire, the depth of fuel bed being governed by the quality of coal being burned. In this picture the grates are all flat and the dumping or cleaning plate closed.

In the next figure the dumping grate has been opened and the clinker and ash resting on it dropped into the ashpit. The shape of structure of this ashpit is a question of local conditions. There is no restriction as far as the stoker is concerned to any particular style of ashpit.

Figure 3 shows the lower section of the stoker bars raised up, throwing the back portion of the fire which is practically all consumed, and the ash and clinker resting on the lower part of the bars, onto the dump plate, ready for the operation as shown in Figure 2.

Figure 4 shows the front section of the fire bars lifted, and moving the freshly coked coal from the front of the grate onto the back part which has just been cleaned. Fresh coal will be then placed on to the front bar, ready for coking.

This front grate bar is made with specially large air spaces, to develop quick ignition when burning high volatile fuel. In some cases it is necessary to fit an ignition arch at the front of the furnace for the same reason. These are modifications to suit different kinds of coal, and make no difference to the general construction of the stoker. A stoker of this kind is easily installed on any existing type of boiler, without alteration to the settings, and with a very slight loss of time. Indeed, it is claimed that they can be installed over a week end. High boiler ratings can be achieved when desired, and maintained for fairly long periods.

(Continued on Page 28)

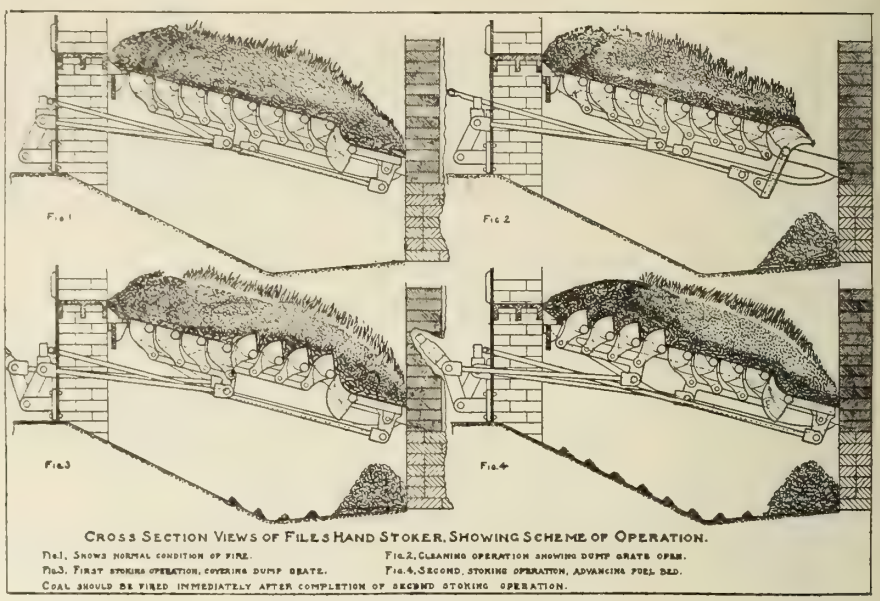
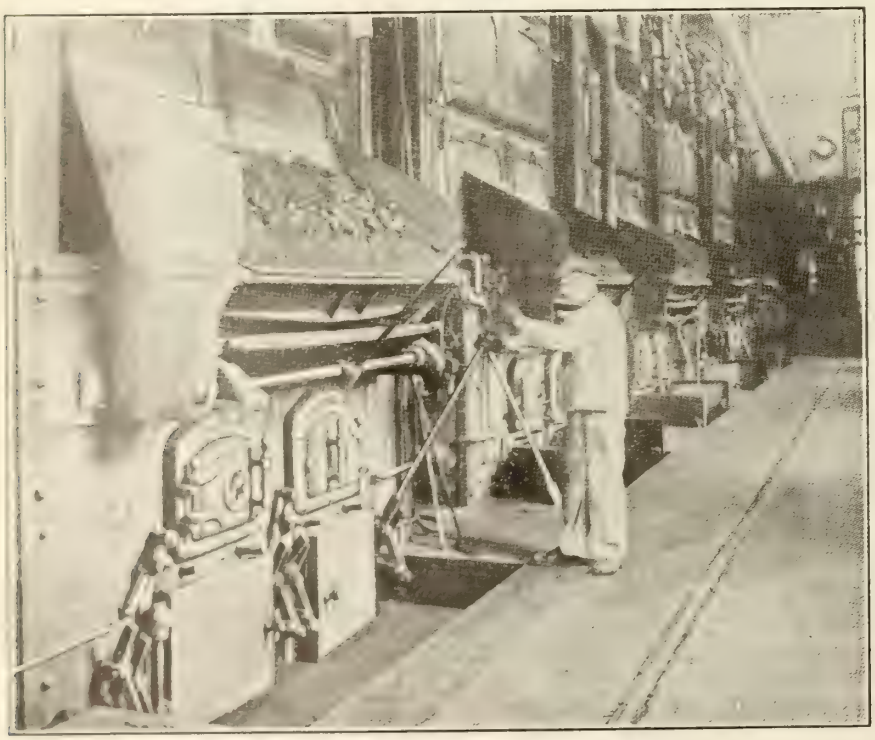


Fig.1
Fig.2
Fig.3
Fig.4
CROSS SECTION VIEWS OF FILES HAND STOKER, SHOWING SCHEME OF OPERATION.
Fig.1. SHOWS NORMAL CONDITION OF FIRE.
Fig.2. CLEANING OPERATION SHOWING DUMP GRATE OPEN.
Fig.3. FIRST STOKING OPERATION, COVERING DUMP GRATE.
Fig.4. SECOND STOKING OPERATION, ADVANCING FUEL BED.
COAL SHOULD BE FIRED IMMEDIATELY AFTER COMPLETION OF SECOND STOKING OPERATION.

Diagram of Stoker Operation.



Installation of Files Stoker and mechanical feed.

Burning Canadian Lignite on Chain Grates

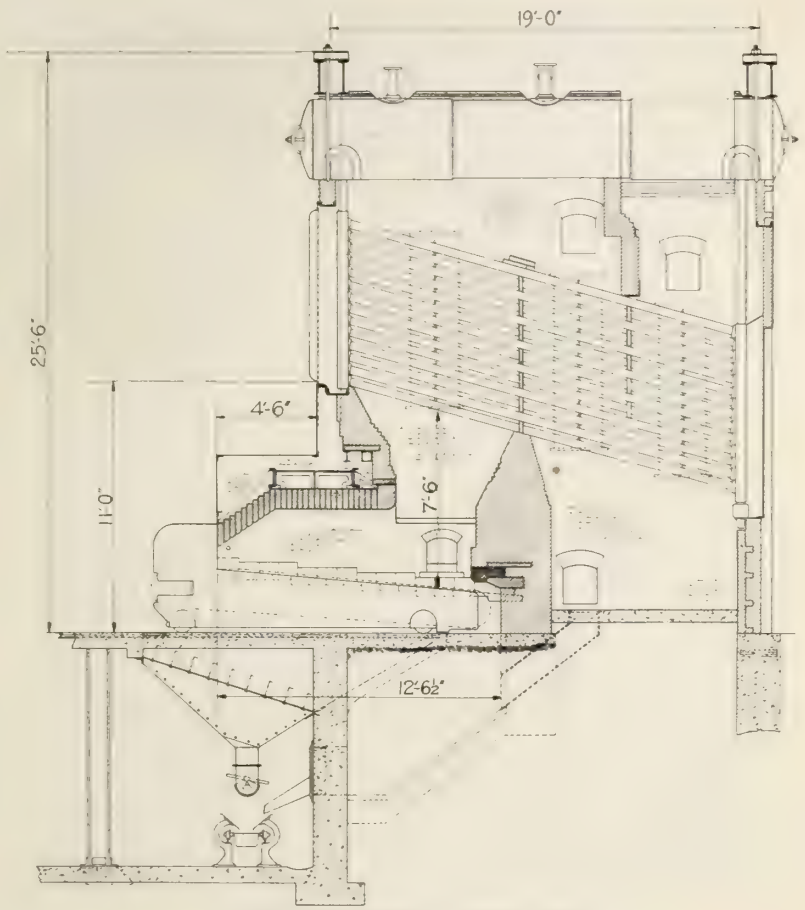
There Are a Number of Installations in Saskatchewan and Manitoba Enabling These Rich Deposits to be Put to Practical Use—A Typical Furnace Arrangement is Described

THE LIGNITE fields of Saskatchewan and Manitoba are rapidly growing in importance as sources of fuel for these and parts of the adjoining provinces. Some idea of the extent of the deposits may be gained from the statement that has been made that at one point on the C. P. R. lines there is a bed of lignite that is actually several hundred feet thick. More effective utilization of the potential natural wealth represented by these deposits has of recent years commanded the very serious attention of the provincial and even the Dominion governments. Among the plans considered are carbonization, briquetting and various combinations of these two processes involving the recovery of valuable by-products. Developments of this nature will undoubtedly be of large importance in the industrial growth of Canada, but the full benefit of this work cannot well accrue for many years. The most pressing need of the moment is an increased use of raw lignite for the production of power and heat to reduce the costly importation of higher grade fuels from other provinces and to assist in lowering the cost of power as a stimulus to greater industrial development.

Several chain grate stoker installations recently made in this district have an important bearing on this matter since the results secured have been highly satisfactory. The lignite burned in many of these plants comes from the well-known Souris fields, and a general discussion of the problems to be met when using this fuel may be of interest.

A typical approximate analysis of Souris lignite follows:

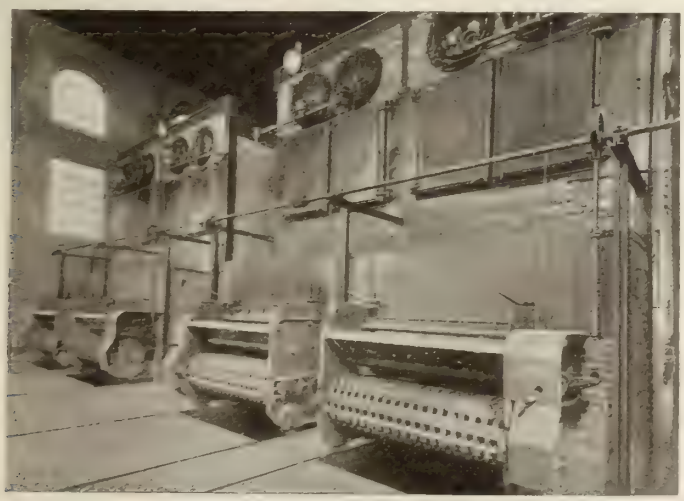
Moisture 31.66 per cent.
Volatile 25.25 per cent.
Fixed Carbon 37.05 per cent.
Ash 6.04 per cent.
B. t. u. 7800.



Laclede-Christy Stoker for burning lignite.

This fuel has all the well-known characteristics of lignite—high moisture, low heat value and pronounced woody structure. It is quite apparent that to obtain high boiler capacities when burning this material it is necessary not only to provide larger grate surface than is required with bituminous coal, but also to pay particular attention to the furnace design and arch placement. Lignite, because of its high moisture content, lights up very reluctantly and since it is obvious that fuel can be burned only as fast as it can be ignited, it is imperative that the furnace, bridge wall and arch layout be such as to induce very high ignition temperatures. This result can best be brought about by providing a high boiler setting, a bridge wall with a high vertical face to reflect heat forward toward the feed gate and a long, high arch to direct the heat full on the incoming coal.

Such a furnace arrangement is shown in the cut of a light line drawing of a typical boiler and stoker layout. It will be noted that there is ample furnace volume and long gas travel before the entrance to the tube bank, which condition makes for complete combustion of the gases arising from the grate. Another matter of note is the provision for high fuel bed temperatures without any suggestion of "bottling the furnace" or restricting the gas exit. These high fuel



Front view of stokers.

bed temperatures are of first importance in inducing high chemical activity of the fuel bed, and hence high rates of burning. This is particularly necessary with lignite because not only does this fuel tend to smolder and glow rather than burn briskly, but to make matters worse the high moisture content very effectively limits furnace temperatures to relatively low values.

The physical condition of the fuel itself deserves more than a passing word. In general the best size for use on chain grate stokers is slack or screenings which will pass through a 1¼-in. or a 1½-in. screen and it is quite necessary that there be a considerable quantity of the so-called "fines" or small particles. Lignite of larger size than that described, or that containing little of the "fines," does not ignite readily and burns slowly and unevenly. While the design of the furnace is of prime importance in burning lignites, yet the matter of draft also demands serious attention. In common with other fuel burning problems it is advisable in these cases to have available a little more draft than the actual maximum requirements. A plant with excellent facilities for the production of good draft is in a much better situation than one in which the draft is limited. In general it may be said that it is advisable to provide between 4 and 5 in. draft over the fire.

These considerations show the importance of insuring the application of the best results are to be obtained. It is sign of a stoker and boiler layout for the utilization of Canadian lignites if the best results are to b eobtained. It is gratifying to know, however, that the application of these principles and practices do make possible high capacities and economies when burning this cheap, low grade fuel.

HAND OPERATED STOKERS

Continued on page 26

A grate of this type gives practically all the features of the purely mechanical stoker, without the heavy initial outlay, which is a big consideration in the small plant.

Mechanical Feed

By equipping the boiler with a mechanical feed system in conjunction with the stoker, and especially if the hopper of the mechanical feeder is fed by coal handling machinery, considerable saving in labor can be accomplished. Even where the hoppers must be filled by hand there is a saving due to the elimination of the opening and closing of fire doors, and the regularity of the feed possible by mechanical means.

This mechanical feed arrangement can be installed with slight trouble, as it bolts right on to the boiler front, and the standard setting is in no way interfered with.

BUREAU OF MINES PUBLICATION

The issue of Technical Paper 268, "Preparation and uses of tar and its simple crude derivatives," by W. W. Odell, fuel engineer, is announced by the United States Bureau of Mines.

The importance of tar as a commercial product has been emphasized during the past five or six years more than ever before, says the author. In that time, the market for tar and its products fluctuated in an unprecedented way, because of the war and other conditions, with the result that the production of tar and tar products increased greatly. A large proportion of the increase is due to the installation of by-product coke ovens, which are fast replacing the bee-hive ovens, from which tar and other by-products are not recovered. The increasing demand for steel and the shortage of anthracite coal during the war were a great impetus to the coking industry. In 1920 tar was being produced in greater quantities than ever before, but the entire output was not on the market for sale, as increasingly large quantities were being used for fuel. However, in some localities where the output of tar was small or was of inferior quality—particularly water-gas tar—there seemed to be no great demand for the product.

This paper discusses the uses to which some of the various tars are put and shows briefly the usual methods of working up tar into some of its simple or easily prepared derivatives, for which a market can generally be found. Although coal tars are given chief consideration, the properties and characteristics of water-gas tar are mentioned for the reason that this tar is often produced in plants where coal tar is made, the mixed tar being collected and marketed, and for the further reason that the presence of water-gas tar in some coal-tar products is specifically interdicted by commercial specifications. This publication is not a handbook on tar distillation, for that subject can hardly be covered adequately in such limited space, but is published by the Bureau of Mines as a general treatise on the utilization of tar.

Technical Paper 268 may be obtained by addressing the Bureau of Mines, Washington, D. C.

FUSE BULLETIN

The thoroughly vented renewable fuse, recently developed by Westinghouse engineers, is discussed and illustrated in Folder 4,472, entitled "Shurvent Protection," which has just been published by the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa.

The folder explains the application and design of fuses for the protection of low-voltage circuits up to 600 volts for both alternating-current and direct-current.

Every part of the Shurvent fuse is described in this folder and pen-and-ink sketches are used to show how the renewal of both the ferrule and knife-blade types of fuses is accomplised. Although Shurvent Renewable Fuses are featured in this publication, various other subjects are covered, such as the conditions which must be met to obtain the underwriters' approval, style numbers, weights, prices and other tabulated data.

The Renfrew Creamery is having its present refrigeration capacity doubled owing to the increase in cream business. The Linde Canadian Refrigeration Co., of Montreal, the same firm that installed the system is making the addition. During the year 1921, the creamery put out nearly a quarter of a million pounds of butter and 13,000 gallons of ice cream. The staff has also been considerably increased.

Erection of four buildings at a cost of $1,500,000 is contained in a request made by the Toronto University to the Provincial Government. This program includes a new forestry and botany building, an administration building, additions to the heating plant and a woman's building.

Mr. C. Little of Robinson, Little Co., 343 Richmond St., London, Ont., plans to build an arena. The cost will be about $150,000. Prices wanted on artificial ice-making equipment.

The following figures show the receipts at the Port of Toronto, Ont., for the last three fiscal years. For the year 1919-20, $43,622,135. For the year 1920-21, $31,490,719. For the year 1921-22, $43,616,887.

Jones & Glassco Reg'd. of Montreal and Toronto, have been appointed the sole Canadian agents for the Unchokeable Pump Ltd. of London, Eng. The Unchokeable Pump is constructed on the centrifugal principle, but so designed that fibrous solids, skins, sacking, etc., will pass through it without difficulty.

AIR DRIVEN WIRE BRUSH

There has been placed on the market recently an air driven brush for which some remarkable results are claimed. The tool is especially adapted for removing paint, rust, dirt, and scale from tanks, cars, and structural steel forms, where the area to be cleaned is large and fast work is required. The speed at which the brush rotates is an interesting feature. Its free speed is 4,200 r.p.m. when 90 lbs. of air is supplied the three cylinder motor. The speed, it is claimed, not only permits of faster working but actually adds life to the brush. Light weight is obtained by using an aluminum casing reinforced with cast-in steel bushings. The complete machine weighs only 14 pounds. The diameter of the brush is 6 in. and the length of the tool over-all is 17-1/2 in. It is claimed that on a prolonged test of the brush, steel gondola cars averaging 540 sq. ft. of surface were cleaned in 3½ hours. Rust and old paint were removed in each instance. The tool is being marketed by the Ingersoll-Rand Co. of New York, and under the trade name of "Little David."

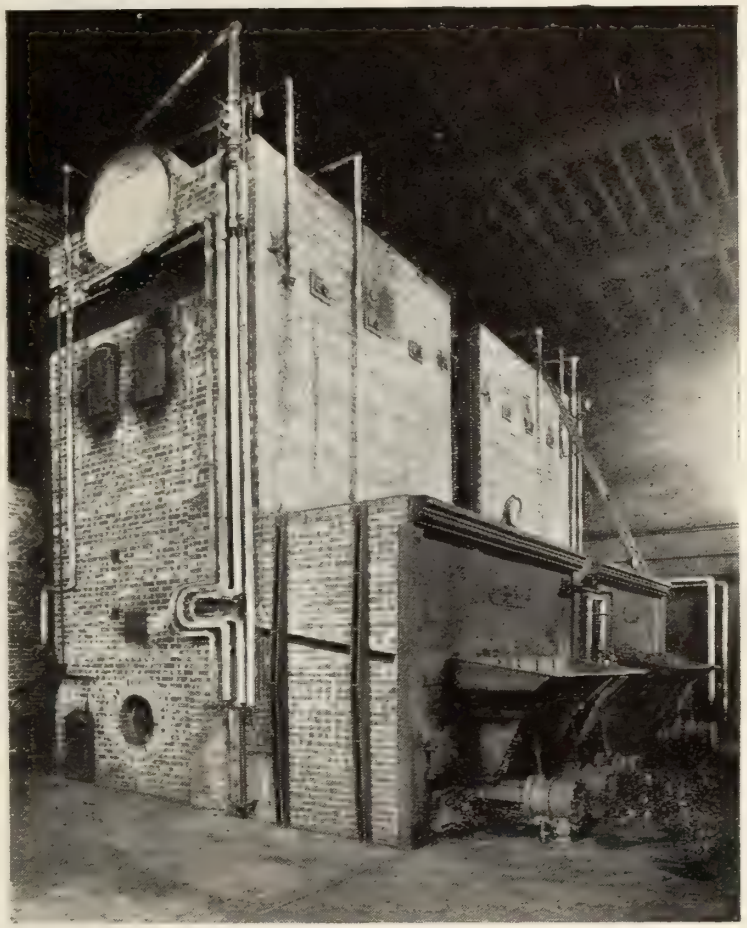
Erie City Boilers and MacLean Stokers

This is the Combination Used in the Plant of the Canadian Dyer's Association, Toronto—The Boilers Are of Water Tube, and the Stokers of the Underfeed Type

THERE is one type of industry which is insistent in its demands for steam in large quantities at uncertain periods, much in the same manner as a central station. We refer to the textile plant, and more particularly to the dyeing industry. This kind of work calls for hot water and steam at almost every step, and the men in charge of the processes have no thought but to get the required heat in the water or the drying apparatus in the least possible time.

This kind of work demands boiler equipment that can rise to the occasion and an interesting installation is to be found in the plant of the Canadian Dyers Association, Toronto. The processes cover the rough or undyed cloth coming from the mills, to the finished article ready for making up.

The cloth as it comes in from the mill is of creamy color, and is far from being in the smooth state that is familiar in the made up goods. In order to produce this appearance it is rolled in special rollers and passed through machines which thoroughly scour it, removing any dirt that may have been picked up. It is then ready to go to the dyeing kettles. There are a large number of these kettles, and then there are the dryers. Altogether the demand for hot water reaches about 400,000 gallons per day. The steam required for drying purposes is furnished at about 80 lbs. pressure, the temperature in the drying room being about 180 degrees.



MacLean Stokers on Erie City Boilers.

The Steam Equipment

The steam generating equipment consists of two Erie City boilers of 400 h. p. each. They are fitted with three retort underfeed stokers made by the MacLean Underfeed Stoker Co., Toronto. These stokers have some interesting features, the chief points being in the method of steam distribution to the ram and the form of tuyeres used in the grates.

Showing Front of Boilers, Hoppers and Stoker Cylinders.

The general arrangement of the stoker is of the usual underfeed type with a ram operated by steam, pushing the coal into the bottom of a trough, underneath the burning fuel. This process causes the gases in the fuel to be first distilled and ignited as they pass through the burning top layer of fuel, and after the gases are set free the remaining carbon is pushed up to the top of the fire, the ash and clinker being pushed over onto the side plates where they can be taken away at cleaning time.

In the underfeed type of stoker forced draft is a necessity, and the air is admitted to the fire through tuyeres placed at the side of the fuel trough. One of the feature of the MacLean stoker is the construction of these tuyeres. The portion which is most susceptible to burning is made separate, but easily fitted into the main body of the tuyere. It can thus be easily renewed, and it is also made in such a manner that the projections which guide the renewable

Enlarged View of Timing Mechanism.

portion into the base, also serve as a preventive of coal siftings dropping into the air chamber. The method of distributing the steam to the ram cylinders is one developed by the MacLean Underfeed Stoker, and differs from the method employed in other underfeed types quite considerably. The following description with the illustrations will make it clear.

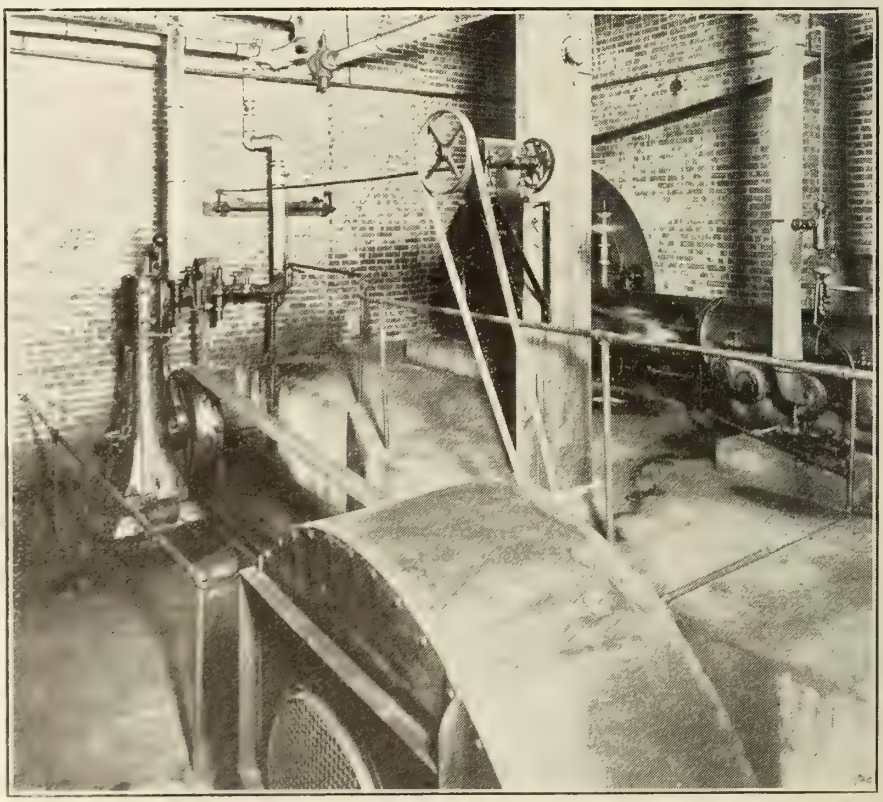
Automatic Control

The automatic feed controlling system of the MacLean Underfeed Stoker is a positive yet simple means of governing the amount of coal delivered by the stoker to the furnace and the quantity of air supplied by the blower. It enables the operator to easily adjust and correctly proportion these to suit the class of coal used, and the demands for steam upon the boilers, so as to automatically maintain a constant uniform steam pressure under all conditions of

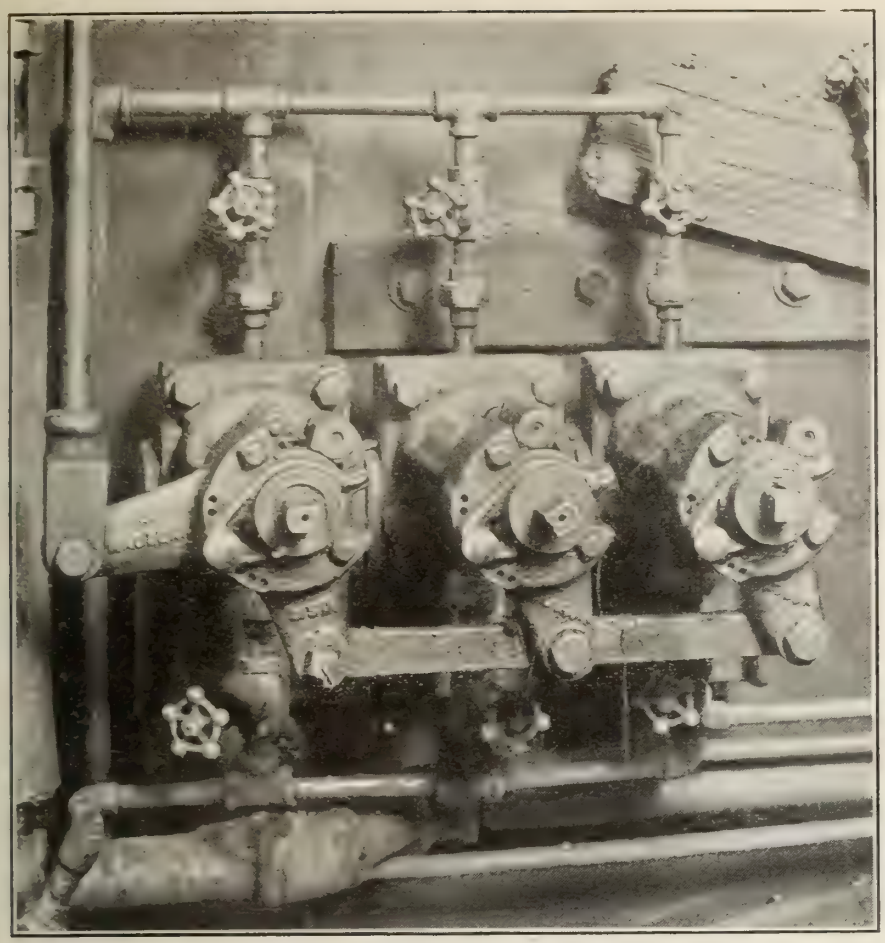
The speed of the steam engine or electric motor driving the blower is controlled by a steam pressure regulator which is set for any desired boiler pressure and is governed by the rise and fall of the pressure itself. Any variation in the speed of the blower is imparted to a reduction gear through a belt drive from a small pulley on the blower shaft, the oscillating motion set up by the reduction gear is carried by connecting rods to an adjustable ratchet operated timing valve which may be located on the boiler front or placed in any other convenient position in the boiler room. From the timing valve a small pipe leads to the main valve steam chest on the stoker cylinder. Fluid pressure is conveyed through this pipe with each rotation of the timing valve and actuates the main valve of the stoker which in turn controls the number of strokes of the piston operated ram and consequently the quantity of coal fed to the furnace.

Following the operation of the automatic control it will be seen that should the boiler pressure fall slightly below the desired point, the steam pressure regulator acts on the motive power driving the blower, increasing its speed, which thus delivers more air to the furnace for combustion. At the same time the speed of the reduction gear is increased, being driven by the blower. This increases the rate of the operation of the timing valve, which in turn controls the speed of the stoker ram and the delivery of coal to the furnace. It will thus be apparent that as the boiler pressure falls the rate of combustion is increased which immediately raises the boiler pressure again.

If the boiler pressure should rise above the desired point the steam pressure regulator will reduce the speed of the blower and the reverse of the above described operations will occur, resulting in the lowering of the rate of combustion in the furnace and the consequent falling of the boiler pressure. The



Fan Engine, Fan, and Stoker Control.



Timing Arrangement

variations of rise and fall of the boiler pressure necessary to alter the rate of the coal feed and air supply are so slight that the result is a practically continuous even steam pressure.

Varying conditions of boiler loads and grades of coal used are easily taken care of. The adjustable ratchet permits the increasing or decreasing of the amount of coal fed through the stoker over a wide range, by setting the index lever so that the pawls take a greater or lesser number of teeth on the ratchet wheel at every oscillation. With this adjustment it is possible to vary the amount of coal without altering the speed of the blower and thus the ratio of coal to air can be proportioned to give efficient combustion. The index lever has eight positions of adjustment, also a zero position stopping the coal feed altogether. The timing valve may also be rotated by a small hand crank and in this way the stoker made to feed any desired number of charges of coal independently of the automatic operation. The design of the timing valve is such that a number of these may be operated together as a set by a single drive without interfering with the provision made for the individual control of the coal feed to each retort. This feature is of great advantage where several retorts are installed in the same furnace or under boilers of different sizes.

The main valve steam chest is cast integrally with the stoker cylinder and the main valve itself which is completely blanked off within the steam chest, operates close up to the cylinder bore making the ports for the admission of steam to the piston very short and direct, thereby reducing the cylinder clearance displacement to a minimum.

The arrangement, it will be seen, tends to great flexibility. The method of controlling the steam supply to the cylinders reduces clearance losses to a minimum, and also simplifies the mechanical parts necessary for operation.

BRITISH ELECTRICAL RESEARCH

Practically every loading section of industry in Great Britain has its organised co-operative research Association. In the case of brass, copper, and other metals not containing iron a great deal of very interesting research is now being carried on. The casting of brass, influence of impurities on the working of copper, the electric melting of non-ferreous metals, and the grinding, jointing, and polishing of such metals are being closely studied. Perhaps the most important part of this research lies in the investigation of corrosion. The production of rustless iron and steel has stimulated the brass and other industries to give attention to the causes of corrosion. It is stated that the examination of tarnishing, which is the first stage towards corrosion, has already yielded very interesting results.

WELDING BY CLOCKWORK

In shipbuilding and in many engineering operations, it is necessary to fix brass studs and other small parts to iron plates. This operation is usually performed by drilling holes in the plate, each hole being drilled separately. By means of an ingenious invention recently perfected by a British firm, the process is carried out in a few seconds by electric welding. The working of the machine is almost entirely automatic from the moment the stud is placed in position. Each size of stud requires a different time for welding it to the plate, and the machine can be set to give exactly the period required to make a perfect weld. The tests which have been made proved that the machine is able to weld 120 brass studs within an hour. It might be thought that welding does not give such a firm arrangement as screwing the stud into a hole in the plate, but when the welded stud is hammered the brass will break before the weld yields. Another advantage of the machine is that work can be satisfactorily carried out by semi-skilled labor.—*100-ton Booster.*

NEW SHAFT COUPLING

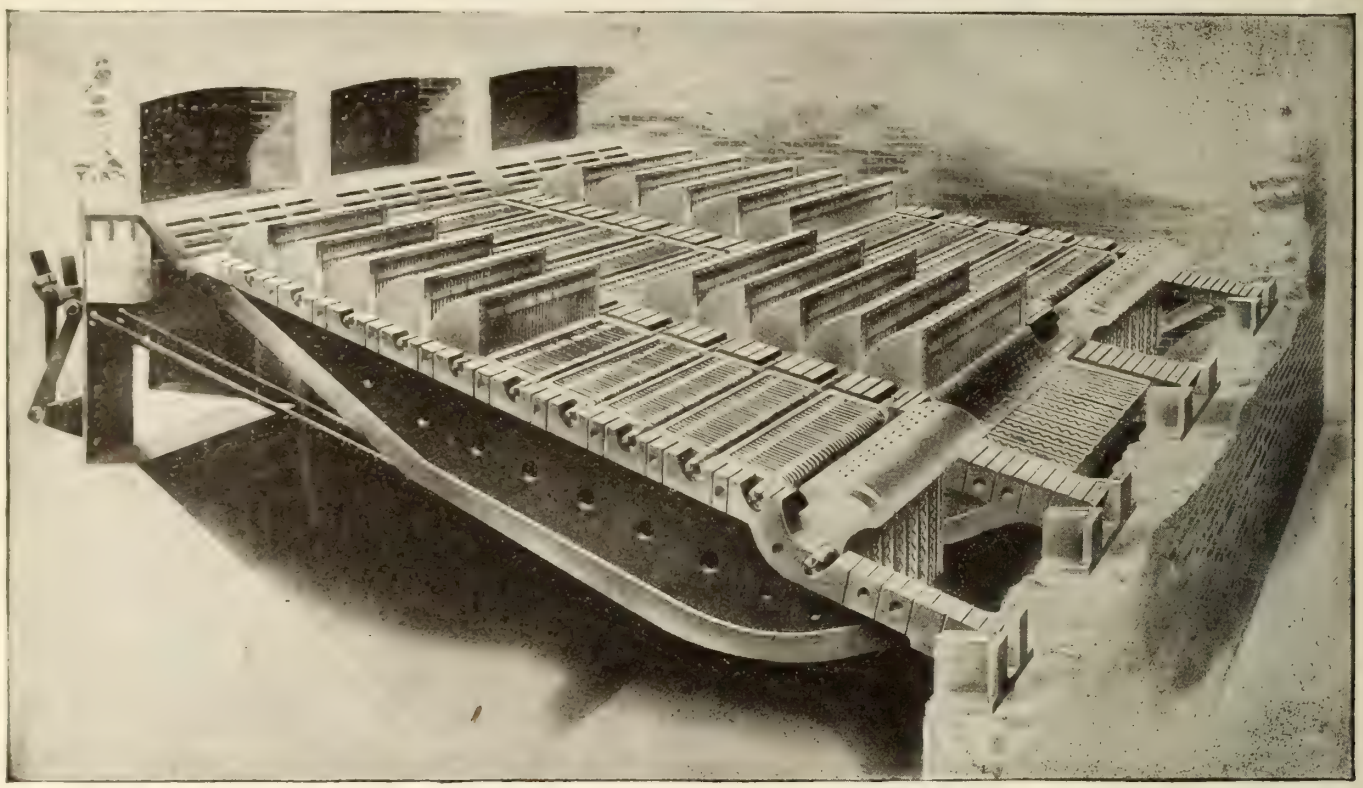
An ingenious method of coupling shafts for power transmission has recently been devised by the Coventry Chain Co. of Coventry, England. It comprises a double chain, i.e., two chains side by side, which passes round toothed flanges on shafts which it is desired to couple. The coupling is readily made by a bolt passing through adjacent links connecting up the two ends of the chain in the usual way. The coupling has a very high factor of safety, it is perfectly balanced, being machined all over, and does not require any lubrication.

The facility for disconnecting the shafts will be apparent, and the method gives a large number of possible adjustments by which one shaft may be angularly set relative to the other through the medium of the teeth into which the rollers of the chain are fitted. Although this coupling is not designed to replace universal joints it is obvious that a measure of flexibility is obtained, and it is stated that the coupling can be used to couple shafts with a deviation in angular movements of two degrees.

Relative end movement between the two shafts is also provided for, limited to about 1-16th of the shaft diameter. A special application of this chain coupling is with regard to automobiles, particularly in such cases as that of the magneto shaft where angular adjustment is sometimes required and where a slight flexibility is considered advantageous to avoid transmission of small vibrations. The coupling is manufactured in fifteen sizes which have been completely standardized, the largest type being capable of transmitting 180 h.p. at 100 revolutions per minute.

Files Stokers

Hand Operated



Simplicity—Ruggedness—Effectiveness—outstanding features of Files Stokers

DUE to the absence of complicated and intricate parts, the average fireman is well able to operate the stoker with maximum efficiency—expert or expensive labor is unnecessary.

Clinker is ground out, ash and refuse removed, coal distributed—the fire is kept clean, uniform, rich—all by the easy, simple movement of the pull-rods at the boiler front. Not once are the fire doors opened to perform any of these operations. Cool air—that destroys draft, chills heated surfaces and strains the boiler—is eliminated.

Consult the perspective view of the stoker. It illustrates the distinctive movement of the stoker bars and the method of removing refuse by means of the counter-balanced cleaning plate. There is no drop in steam pressure nor is live coke lost into the ashpit during these operations.

Perforations and corrugations throughout the various stoker parts provide constant circulation and proper distribution of air (absolute necessities for efficient combustion), and prevent warping or burning of these parts. Ample provision is made for expansion.

Combustion is complete at all times; maximum evaporation is guaranteed; overloads carried for long intervals are a natural requirement easily met by the stokers.

The entire stoker is designed simply but ruggedly; to insure continuous service with smallest operating and maintenance costs. Numerous plants—large and small—are benefiting from these exclusive features of Files Stokers.

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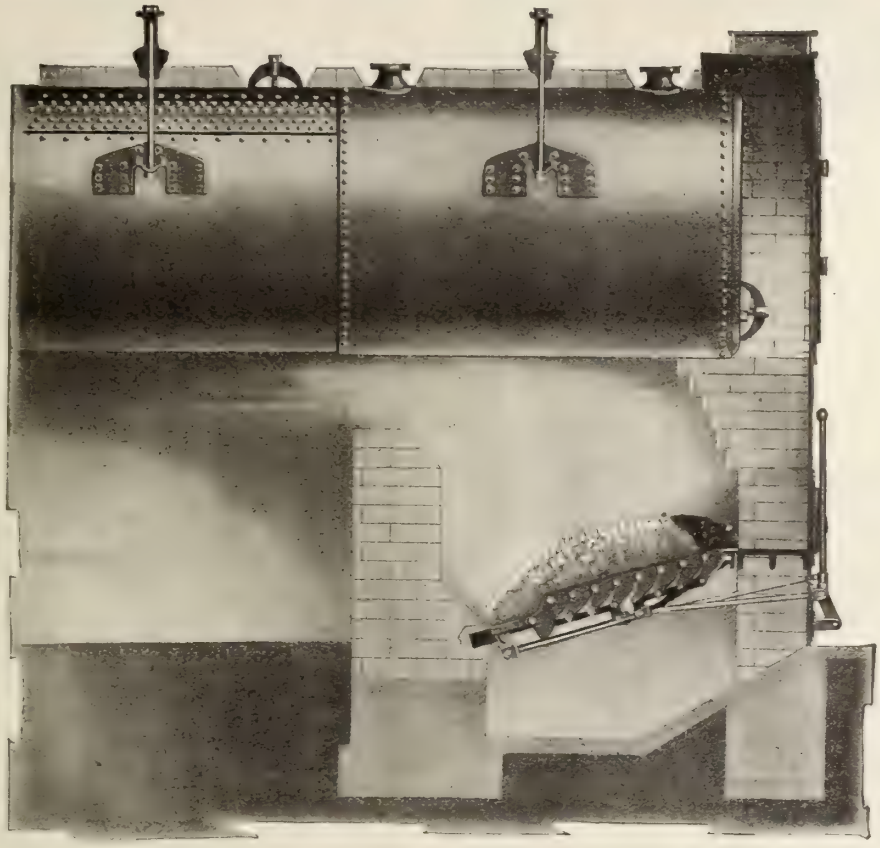
BRANTFORD, ONTARIO, CANADA

FILES HAND STOKERS



Over 500,000 Horse Power of Files Stokers in Operation

INSTALLATION—

The Files Hand Stokers can be easily installed in a few days. The boiler setting is not disturbed in any way except the deepening of the ash pit to accommodate the slope of the stoker. No alterations to boiler fronts are necessary other than drilling of holes for operating levers.

FUEL—

Aside from burning all grades of bituminous coal, heavy mixtures of anthracite or screenings mixed with bituminous coal or mixtures of coke and similar fuels can be used with excellent results with Files Hand Stokers.

The Files Stoker is not only applicable to all types and sizes of boilers, but extends its line of usefulness to all equipment burning coal for fuel, including furnaces, stills, ovens, etc. In each instance the high degree of combustion efficiency, that it maintains, is a source of great saving and profit to all who have installed it and invariably found it the most reasonable investment and the most effective equipment of its kind.

Write us for full information and catalogues.

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BRANTFORD, ONTARIO, CANADA

Member of the Audit Bureau of Circulations

POWER HOUSE

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"Dad" Wickens Passes

AFTER A LIFE full of activity in his chosen profession, Albert M. Wickens, known by all his friends as "Dad" Wickens, passed away at his Toronto home on April 7th, at the ripe age of eighty.

In the year 1885 he moved to the city of Toronto and took the position of chief engineer for the Globe Printing Co., retaining it for seven years. During his term of service the premises were moved from their original location at the corner of what was then King St. E. and Victoria Lane to their present location, and this removing was performed without the loss of a single edition of their paper. This was largely due to the preparation and foresight of the chief engineer. In the new premises Mr. Wickens installed what was the first electric drive in Canada.

His next appointment was that of chief engineer of the Parliament Buildings in Queen's Park. Here again "Dad" was able to show his originality in the matter of electric fittings, a large number of which were made from his own patterns. He included in his duties at the Parliament Building the inspection of all boilers in the Provincial government buildings.

Resigning from the Government service, he was appointed chief engineer of the boiler department of the Canadian Casualty and Boiler Insurance Co., which later became the General Accident Insurance Co., which position he held until he retired about 1912. He was connected with the company up till two or three years ago as a special executive.

"Dad" Wickens was always very active in work for the betterment of the status of his fellow engineers. He was the founder of the Canadian Association of Stationary Engineers, and was active in its service almost continuously from its inception to the time of his last illness. He also organized the Ontario Association of Stationary Engineers, which society ceased to exist with the inauguration of the compulsory certificate, which was the object it had in view. He later was instrumental in organizing the United Craftsmen's Council in Toronto, and saw it grow until last year the first convention was held in Toronto, being attended by members from all over the U.S.A. and Canada.

Probably one of his most useful works was the part he played in bringing into existence and to ultimate success the Toronto Technical School, in collaboration with Major John A. Carlaw, the late Mr. J. A. Orr, and Mr. A. G. Horwood. "Dad" served continuously on the Technical School Board until it was absorbed by the Board of Education.

He was a member of the Masonic order, being connected with Rehoboam Lodge, and was also a member of the I.O.O.F. and was a Presbyterian.

He is survived by three daughters, and two sons, a brother also surviving him.

The Stoker Era

THIS MIGHT well be termed the era of mechanical stoking in power plants, the hand method of firing having been eliminated in all but the smallest plants, while in them it is possible to use a type of stoker which while not being entirely mechanical, yet fulfils the purpose to some extent. This issue of Power House contains a number of articles on typical stoker installations, most of the plants being of medium size, while the semi-mechanical stoker is represented also.

As in the case of the steam boiler, while it is divided into distinct types, there are a great number of makers of these types, each of whom lends some touch of individuality to the apparatus he manufactures. It is gratifying to know that there are a number of stokers manufactured in Canada, some of them being built by subsidiary companies of American firms, others being purely Canadian in their origin and direction. The application of mechanical stoking to Canadian industrial power plants is likewise getting wider every day.

There is practically a stoker for every type of plant, even the small one of one boiler being susceptible of improvement by the installation of some form of stoker or movable grate bar, which will tend to increase efficiency. In the very small plant this is the whole function of the stoker, as in the nature of the case it cannot well eliminate labor. In the larger installations, however, the stoker not only gives more efficient combustion, making a saving in fuel, but it also saves labor, making a direct saving of wages. It also offers the possibility of running boilers to high ratings, thus making a further reduction in fixed charges, both on the investment in the equipment, and in the amount of space to be allowed for power generation. When a factory or central station is situated in the high rental district of a large city this is again a consideration. When stokers are installed in conjunction with their natural complement, ash and coal conveying machinery the plant reaches its highest possible efficiency.

It must be borne in mind, that no matter what kind of machinery is installed, and how well it may be designed for the part it is to play, it will have but little chance of success unless it has the benefit of skilled and careful attention. It is a great mistake to assume that because a plant has been equipped with high priced automatic machinery, that the commonest kind of labor can be used to operate it. The machinery has eliminated just that kind of labor. The men who are still necessary for its operation should be the best available, and their compensation should be based on an appreciation of the value of the machinery in their charge.

Progress in New Equipment

A New Type of Multiple Underfeed Stoker

Many Advantages Are Claimed for the Stoker Described in the Following Article, and Curves of Both Calculated Performance and Actual Performance Are Given

By ROBERT JUNE

THE GENERATION of steam with coal as fuel has been practically revolutionized within the past few years. Boilers have been driven to capacities hardly dreamed of ten years ago. As a result, very much higher over-all efficiencies have been secured. The cost of production has been materially lowered, due to the lessened number of boilers required, and to economies effected in fuel saving, labor and maintenance.

This great difference has been due to the development of the underfeed stoker. The superiority of this type of stoker lies in its range of capacity, its complete mixing of air and fuel, and its provision for the removal of ash at regular intervals.

The multiple retort stoker is the stoker for large installations and exceedingly high ratings. Indeed, so completely has the forced draft stoker preempted this field that it is unusual to go into a large central station or high duty large-power plant of any sort built within recent years, and find any other types of stokers installed.

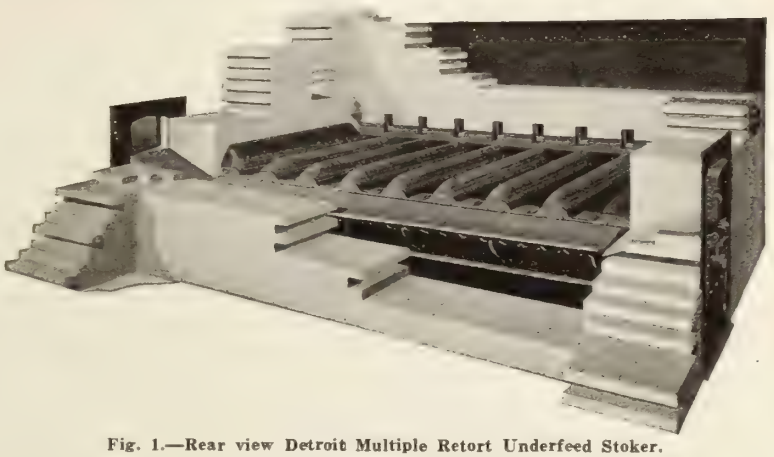


Fig. 1.—Rear view Detroit Multiple Retort Underfeed Stoker.

There are a number of reasons for this. First of all, the underfeed stoker is adapted to all grades of bituminous coal. Next, it is essentially a forced draft stoker, since it operates with restricted air openings, and very deep fires. The forcing capacity is almost unlimited, instances being known where this stoker has been driven to over 400 per cent. rating.

Fig. 2.—Front view Detroit Multiple Retort Underfeed Stoker.

Stoker Designed on New Principle

The design of the underfeed stoker provides for a driven ram, which forces the fresh coal into a large receiving retort, contained within the furnace, and from there up under the fuel bed. Designers of the earlier types of underfeed stokers considered it essential that the fuel bed should be inclined at an angle of 20 to 30 degrees, in order to facilitate the rearward movement of the fuel. The influence of the earlier designers in this particular respect has largely controlled stoker design until the present day, although the fact has long been recognized that a steeply inclined fuel bed possesses serious disadvantages. Such a fuel bed is irregular in structure and at times may contain large lumps of coke, or quantities of clinker, or of soft unattached coal. In pushing a fuel bed so composed down an incline, an irregularity of movement occurs, and slides are occasioned which roll large bodies of fuel on the dump plates. When such slides occur, very marked irregularities in the thickness of the fuel bed are caused, and

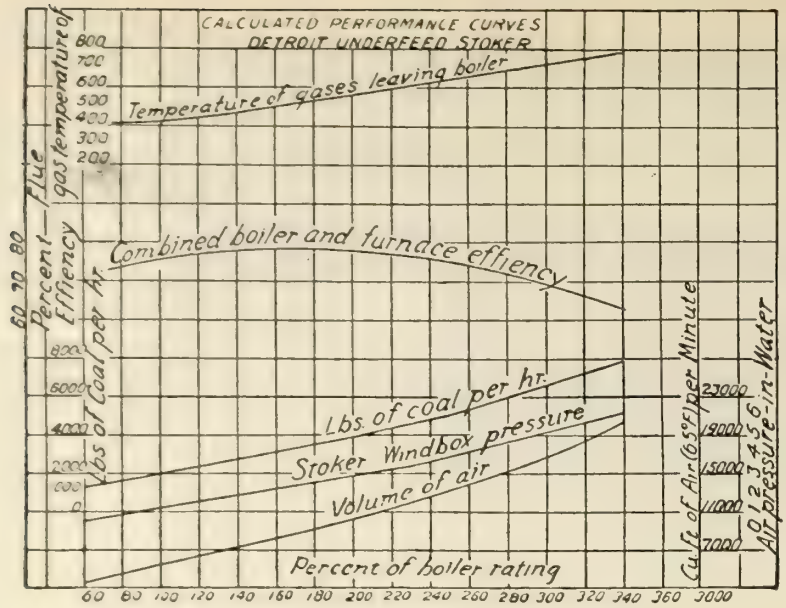

CALCULATED PERFORMANCE CURVES
DETROIT UNDERFEED STOKER
Temperature of gases leaving boiler
Combined boiler and furnace effiency
Lbs of coal per hr.
Stoker Windbox pressure
Volume of air
Percent of boiler rating
Percent—Flue gas temperature—Efficiency
Lbs of Coal per hr.
Cuft of Air (65°F) per Minute
Air pressure in Water

Fig. 3.—Typical Test Performance Curves.

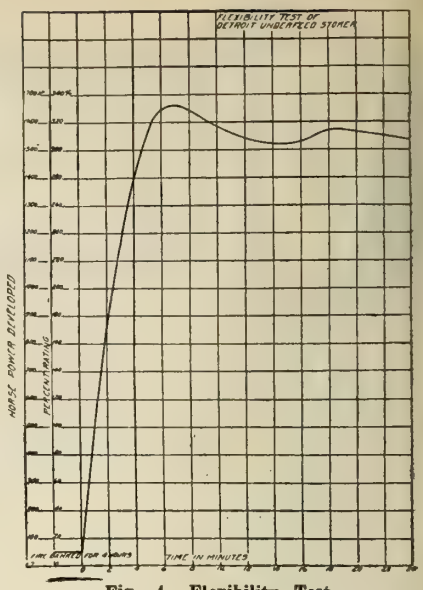


Fig. 4.—Flexibility Test.

there is frequently a heavy fire on the dump plates, the net result being lowered combustion efficiency and ideal clinker forming conditions on the dump.

In order to overcome these disadvantages, the Detroit Stoker Company, Detroit, Michigan, has designed an entirely new type of underfeed stoker. This stoker is made in two designs, for boilers up to three or four hundred H. P. Over one hundred installations have been made of this stoker and all are operating successfully.

The larger stoker is of the multiple retort and cleaning type for large installations. This stoker is designed on principles which have been successfully worked out in the smaller machine. It has been thoroughly tried out for two years under all conditions of operation.

In describing the new stoker, we will deal first with the multiple retort type, (Fig. 1 and 2), and then describe briefly the modifications of this found in the smaller retort design.

Multiple Retort Stoker

To feed coal into one end of a furnace, to move it to the rear at such a rate, and under such control, that combustion is entirely completed within the furnace and only refuse reaches the dump, is in itslf an innovation. To do this in such a way that combustion is uniformly progressive throughout the entire length of the fuel bed, and to do it with fuels of different characteristics, is an accomplishment that marks a distinct step forward. It is this accomplishment which distinguishes the Detroit Multiple retort underfeed stoker. Adequate recognition has been taken in the design of the conditions existing in a moving fuel bed, and positive means provided for controlling these conditions. To accomplish this many old theories now in practice with underfeed stokers had to be abandoned.

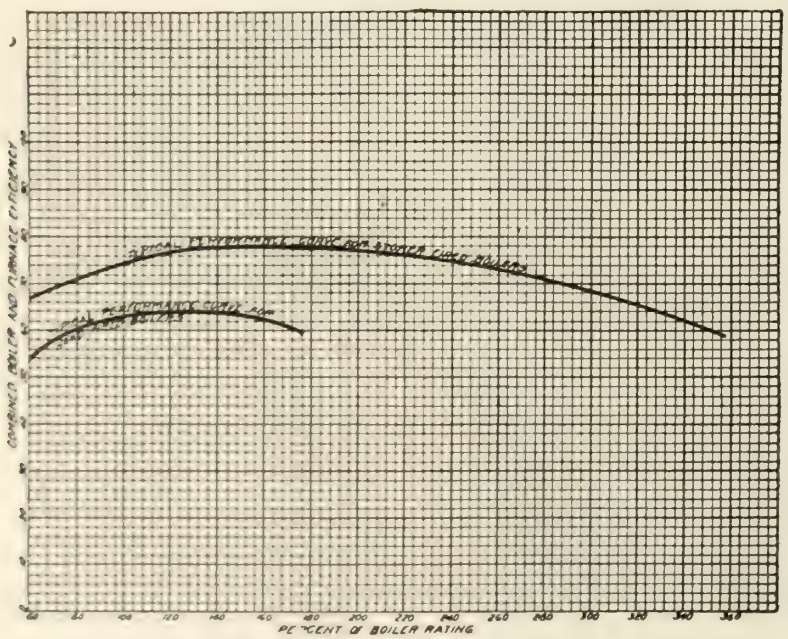


Fig. 5.—Calculated Performance.

Level Fuel Bed

The striking feature of the new stoker is a level fuel bed, which does away with the causes of uncertainty of the fuel movement. A positive feed of the fuel is provided, giving for the first two-thirds of the travel an upward and rearward movement, and for the remaining one-third a horizontal push to the dumping device.

Retorts and Tuyeres: Are for the first time placed horizontally, and the thickness of the fuel bed, together with its rate of movement to the rear, are at all times under the control of the operator.

Auxiliary Pusher: An auxiliary pushing device of entirely new design is provided. It is so proportioned as to give a graduated retardation to the movement of the fuel as it approaches the dump, and the movement is adjusted to suit different grades of fuel. The positive and continuous movement of the pushing device prevents the formation of large clinkers, delivering the refuse to the dump in comparatively small sizes.

Mechanically Driven Rams: Fuel is delivered to the retort by means of heavy crank-driven rams. The connecting rods operate through specially designed boxes provided with a lost motion arrangement which permits an adjustment of the length of travel of the ram from no movement to full stroke. This permits the instant release of any ram, or all the rams can be run at short stroke for very light loads. When fires are banked, all rams can be left standing in, preventing back-firing to the hoppers.

Air Distribution: Of equal importance with distribution of fuel is distribution of air. The latter must flow through fixed openings to the fuel bed. It is evident, therefore, that the greater the number of retorts in a given space, the easier it is to effect an intimate mixture of fuel and air. The Detroit Underfeed Stoker has narrow retorts spaced as closely together as mechanical construc-

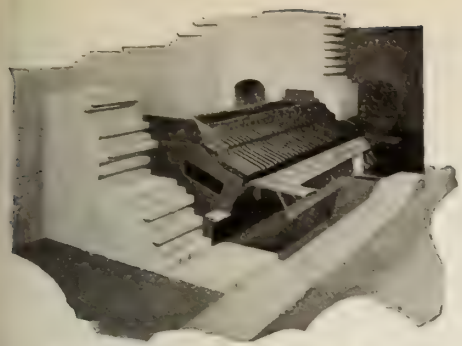


Fig. 6.—Rear view Detroit Single Retort Underfeed Stoker.

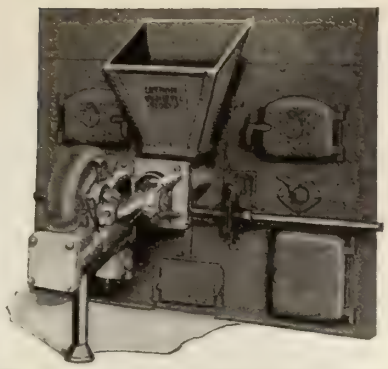


Fig. 7.—Front view Detroit Single Retort Underfeed Stoker.

tion permits. Tuyeres are simple in design with numerous openings arranged to discharge air evenly throughout the fuel bed, and so spaced that all parts of the bed can be reached with comparatively low air pressure.

Regulation: For best results it is essential that the feeding of fuel and the supplying of air be properly co-ordinated. In the Detroit Underfeed Stoker much thought has been given to constructing a machine that in operation will bring the air and fuel into intimate relation in proper proportion for complete combustion. Means have been provided for maintaining this proportion as the rate of feeding and burning alters. Any of the present systems of automatic stoker control can be used in connection with the Detroit Underfeed Stoker. In addition to the automatic control, the independent hand control of each ram enables the operator to shape the fire properly and to maintain it in proper condition for best results at all times.

Automatic Operation: One of the principal requisites of satisfactory stoker operation is that it shall be automatic as far as possible. It is, however, a fact well recognized by power plant engineers that the human element must enter into the operation of a stoking machine. This is due to sudden changes in load, fuel and many other factors, all tending to increase or decrease the fuel consumption. The Detroit Underfeed Stoker has been made as nearly automatic as the conditions of combustion permit. The principles of design and construction employed render it extremely responsive to automatic control. The designers have had the operator in mind and have given him every aid in the way of simplicity of operation, to the end that he can readily understand and manipulate the stoker.

Efficiency and Capacity

The chart, (Fig. 3), shows a typical test performance of the new Detroit Underfeed Stoker at capacities ranging from 60 per cent. to 350 per cent. of normal boiler rating. It will be seen that the combined boiler and furnace efficiency drops a little as the load increases. This indicates a high degree of economy under normal load conditions and a very high and economical reserve capacity to meet unusual loads.

Flexibility

The extreme flexibility of the new stoker is indicated by the chart, (Fig. 4) taken from actual test. This test was made on a 500 H. P. water tube boiler. The fire had previously been banked for four hours, with the boiler developing only about 10 per cent. of its normal rating. From this test it will be seen that one minute after the heavy load was placed on the boiler it was developing normal rating and within two minutes it was developing 200 per cent. rating and within four minutes a rating of 300 per cent. which was held without difficulty. The ability to meet peak loads quickly is of the greatest importance, as far as stokers for central stations are concerned, and it is even of almost equal importance in large industrial plants, particularly those where quantities of steam are at times required for manufacturing processes. In particular when the number of boilers in a plant is limited, extreme flexibility on the part of the stoker installation is an invaluable asset.

Calculated Performance Curves

A comparison of the calculated performance curves, (Fig. 5) of the new stoker, with the actual test curves, (Fig. 1), shows the results achieved in practice to exceed those theoretically determined. The ability to meet performance guarantees readily is of course, extremely desirable, and the new stoker has so far fulfilled every expectation in this respect.

Single Retort Side Cleaning Stoker

The single retort, side cleaning stoker, (Figures 6 and 7), is designed on the same principle and possesses all of the advantages of the multiple retort stoker just described. It differs in design from the latter however, in the location of the dump, which is placed on the side. This dump is hand operated and refuse can be removed either through ash doors in the front, or delivered below to a hopper or ash conveyor.

The arrangement for admitting air, under control through specially designed tuyeres at both sides of the retort, produces a high overload on quick demand. The regulation of feed of the coal and removal of the clinker and ash are both accomplished without interference with operation of the stoker.

This smaller stoker has a mechanically driven plunger or ram operated by reduction gears from a shaft below, driven by a small engine or motor. All gears, worms and moving parts are fully enclosed, running in oil and are easily accessible. The simplicity of the design without any moving in the fire, insures a minimum maintenance cost.

The control of the air in the wind box and the convenient arrangement for regulating the amount of coal to be burned in accordance with the load required, produces a uniform steam pressure in the boiler.

ARTIFICIAL DAYLIGHT

One of the most interesting problems in illumination is to provide an artificial source of light which will exactly reproduce ordinary daylight. One way of obtaining the desired result is to filter the light of an electric or other lamp through special glasses, but a British inventor recently produced another form in which all the light is reflected from an umbrella shaped reflector on which patches of certain colours are painted. All the light used comes from this reflector and is modified by the colours to give a very exact imitation of daylight. An improved form of this artificial daylight apparatus has just been patented. The reflector consists of two layers of material perforated with holes so that a certain number of spots of the colours are exposed. Radial strips of another colour are placed over the perforated layers, the whole arrangement being mechanically strong and giving the correct areas of the various colours to provide artificial daylight.

BRITISH TRADE SHIP

Some time ago arrangements were completed for the building of a special vessel to act as a floating exhibition of British manufactures. For various reasons the voyage of this ship has been postponed for a year or two. Meanwhile a large British liner has been acquired for the purpose of being converted into a trade ship. The cabins will be used for the accommodation of the representatives; and the holds and other portions of the vessel will be adapted for exhibition purposes.

MONEL METAL FOR VALVES

Monel metal resists the eroding and corroding effects of hot steam, has a comparatively low co-efficient of expansion, and one which agrees very closely with that of cast steel. These three qualities make it particularly suitable for the seats, discs or other wearing parts of high duty valves. The non-corrodible feature causes resistance to superheated steam, the expansion similar to steel keeps the seats in the same relation to the steel bodies usually used for these valves, and the comparatively low expansion brings about retention of size and shape at all times. For this reason it is widely used, and a majority of the higher class high duty valves are trimmed with monel.

R. P. Ross & Co. of Sudbury, have secured contracts on behalf of the Standand Steel Construction Company Limited, for all the construction steel work on the Copper Cliff school and the Salvation Army citadel, Sudbury.

Buying Stoker Replacement Parts

By RUSSELL T. GRAY

From "Combustion."

THERE is no other piece of equipment in the modern plant that is worked as hard as the stoker—and abused as much.

And yet, all the better-known makes of mechanical stokers stand up remarkably well under long overloads and abuse. When replacements of wearing parts are necessary, however, spare parts should be ordered with the same care that marked the original purchase of the stoker.

New equipment is not bought by the pound, like so much cast iron. The man who buys a stoker buys the raw material plus the engineering skill and experience that is necessary to shape that material into the smoothly-functioning apparatus that he wants in his plant, which may be the result of years of patient, day-after-day striving for betterment.

Just as a great painting is judged by the "brains that are mixed with the paint" and not by the amount of paint daubed on the canvas, so is the worth of engineering equipment determined by the "brains that are mixed with the cast iron."

This is just as true of replacement parts as it is true of the original stoker. Spare parts that are not made by the same maker as the stoker, are only so much cast iron without the brains—and worth no more than the current market price for castings.

Some engineers order spare parts from local foundries, in the belief that a penny saved is a penny earned. High freight rates have tended to increase such local buying, with the results that many stokers repaired with parts cast at local foundries are falling down under the daily grind, not because of stoker faults but because the new parts interfere with the proper operation, rather than help.

Many complaints received by stoker manufacturers are directly traced to poorly fitted pieces made locally, which at first might be considered of little consequence. But when the perfect operation of every part of a machine is dependent on perfect operation of every other part it may be easily understood why one misfit causes unending trouble with all the working parts. It is absolutely necessary that spare parts fit accurately, and only parts made by the original manufacturer can be depended on to answer these requirements.

Stoker parts that are subject to intense heat are usually made of a grade of iron or steel, which has been found to give the longest service under the particular conditions surrounding that part. When these pieces finally burn out, the engineer who orders replacement parts from his local foundry usually finds that the new parts he has bought soon burn out or begin to warp and buckle. This is because such castings are made of ordinary gray iron, like window sash weights, which cannot withstand the high temperatures.

The engineer who understands that the main spring in his watch cannot be cast iron, but the highest grade of crucible steel, realizes that all iron or steel is not the same.

Every stoker manufacturer maintains a service department with the sole object of making replacements at the lowest cost to user and keeping equipment operating satisfactorily. The reputation of the manufacturer is behind every extra part sent out by service department. If it doesn't fit or doesn't wear, the manufacturer makes good. If the locally-made casting isn't right, the engineer holds the bag.

New improvements that are added from time to time are sometimes incorporated in old stokers by the service department so that the engineer who buys parts from the manufacturer keeps his stoker up-to-date at very little extra cost.

It's a rather serious affair when a man's heart stops beating. And sometimes it's almost that serious when a stoker stops stoking. Therefore it would seem to be clear that enough spare parts should be kept on hand to insure continuous operation. Better too many spare parts, that fit, than a carload that do not fit.

New Suspended Arch

THE advent of the mechanical stoker brought in its train problems relating to brickwork in the furnaces, and of the overhead arch in particular. There have been many developments of this arch, the suspended type gradually being evolved. We illustrate here one of the latest types of suspended arch, made by the Murphy Iron Works, Detroit.

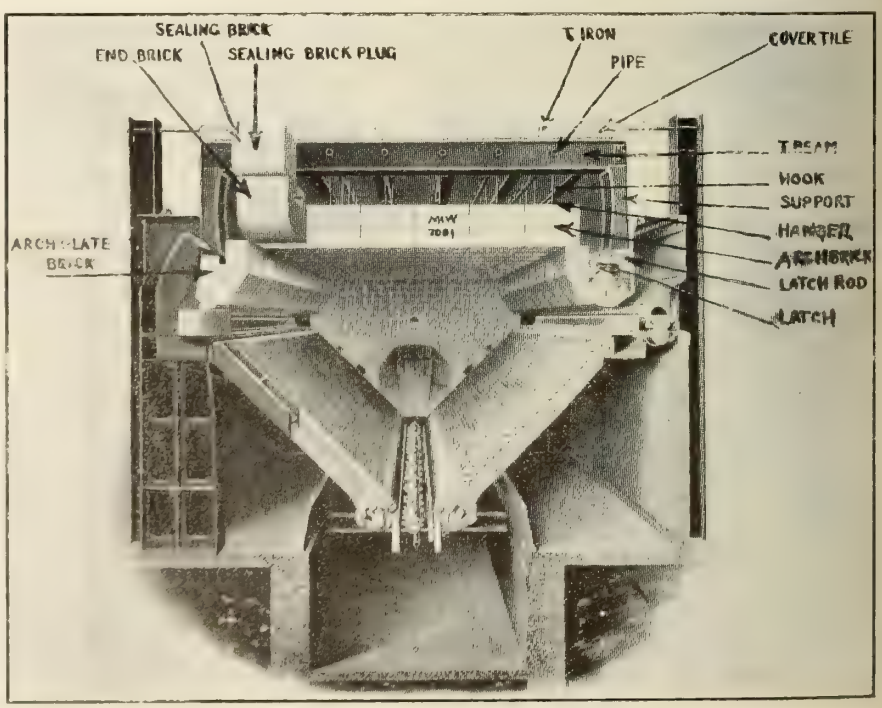
The illustration gives the idea pretty clearly, and the brief description will supply the rest of the information needed to understand the principle.

The arch consists of a number of slotted blocks, each independently hung from longitudinal pipes, which are in turn supported from transverse I beams. The pipes are perforated at the rear end, and open at the front, and the furnace draft draws air through these pipes, keeping them cool, and delivering the air in small jets at the point where it is most needed.

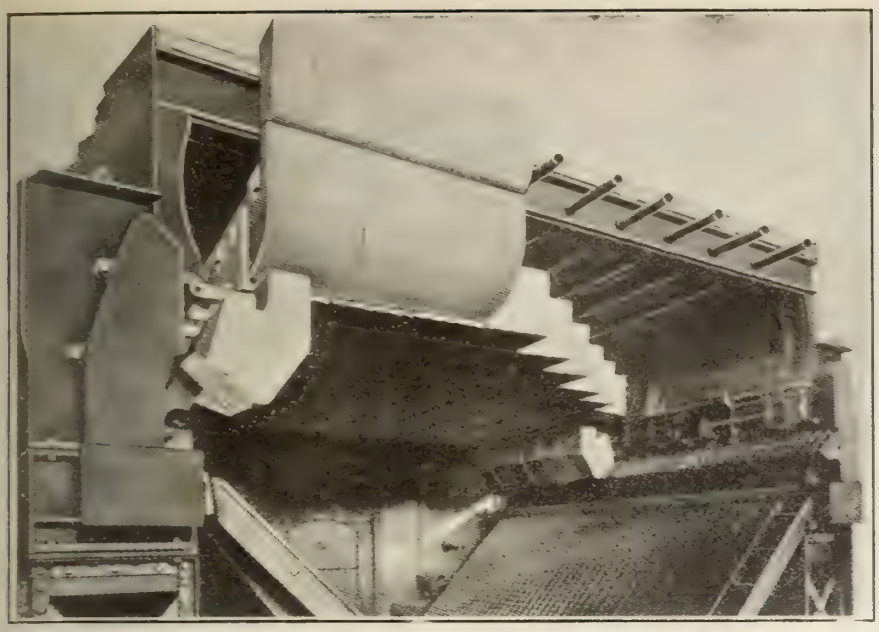
The space at the rear of the arch is closed by two special blocks, so attached that they cannot be forced off the supporting members by the expansion of the arch.

The arch plate bricks are also independently supported and can be quickly removed and replaced without interfering with any other portion of the arch. The air space above the fire brick arch is covered or closed by cover tile resting upon T irons and arranged with deflector plates to insure the correct distribution of air. The arrangement for air distribution and cooling the arch has been carefully designed as the result of long experience in the design and construction of furnace arches.

Every brick in the arch is independently supported and can be removed and



General Arrangement of Arch

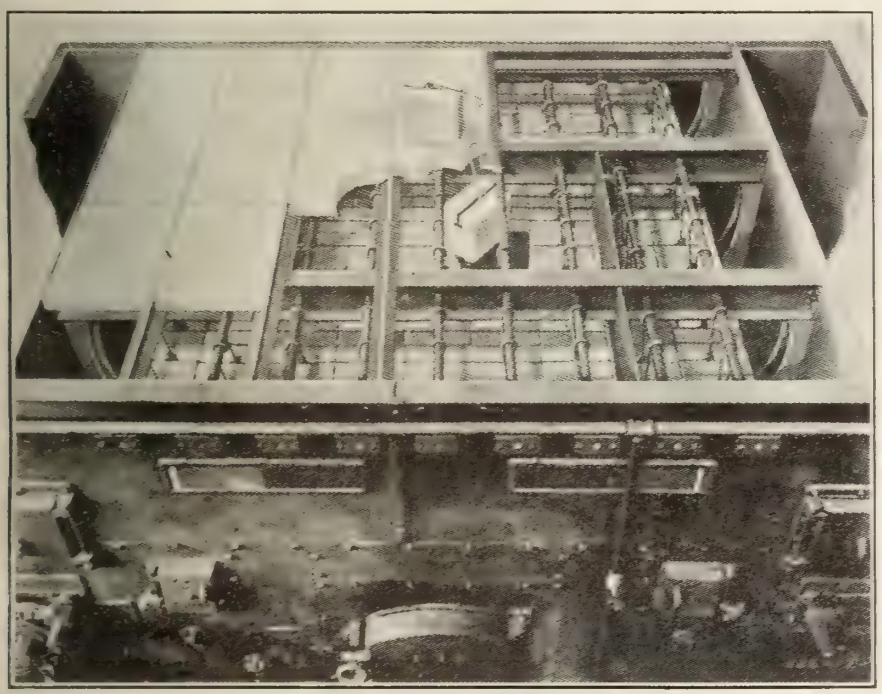


Showing arrangement of front blocks.

replaced without disturbing the balance of the arch.

An arch generally requires repairing rather than the renewal of the entire arch, and if a local deterioration can be repaired easily and inexpensively the life of the arch is lengthened many times.

By referring to the illustrations, it will be seen that by simply lifting off the cover tile, any brick in the roof of the arch may be removed and replaced without disturbing any other brick and this, if desired, can be done while the furnace is in operation.



View on top of arch looking down.

ARMATURE PRESS

An armature press that is intended for the use of electrical repairmen has recently been placed on the market. The construction and capacity of the press enable it to be employed for assembling operations such as putting in place piston flags, spindle bushings, gears and similar work. The frame is of cast steel and is capable of withstanding a pressure of 3,000 pounds. It is 17 in. in height overall, and an opening provided in the base is 5 in. in dia. A hardened steel plate, made in two pieces, having three different sizes of openings is furnished to accommodate small work. The plate is held together by two bolts. The two halves can be slipped under the bearings of an armature shaft so that the shaft can be pressed out of the bearing. The working height between the plate and the bottom end of the arbor, in the raised position, is 9¾ in. The press is manufactured by the Napier Machine Co., Inc., of Napier, Ill.

A RECORD CASTING

The largest iron casting ever made in reat Britain and one of the largest ever produced in any country was recently turned out in a British factory. It weighed 110 tons and the mould was built in a 16 foot pit. Seven hours were occupied in melting the metal, and the casting was poured in just under five minutes. Three weeks were occupied in cooling the casting. Owing to its enormous size and weight the casting had to be delivered by road, six traction engines being used for hauling it.

PORTABLE BENCH SAW

A portable bench saw that is adapted particularly to light work in cutting and fitting wood parts, has recently been placed upon the market. The machine is motor driven and is self contained. The base carries a one piece table upon which the motor and saw are mounted. The table and saw can be swung to any angle up to 45 deg., in either direction. This feature is very useful in cutting moulding for mitre joints. The motor and saw are mounted on a frame that swings about a horizontal axis. The saw is normally kept in an elevated position by means of a coil spring. The power is transmitted from the motor to the saw arbor by means of a belt, which is provided with a screw adjustment to maintain the proper tension. The belt and pulleys are fully protected by a metal guard. The saw has a combination of both large and small teeth. A metal housing covers the saw, and from the front of this housing there projects a handle for depressing the saw. The motor control switch is near the saw control handle, on the metal saw guard. The bottom of the saw is protected by a metal guard on each side of it. When the saw is elevated the guard is locked in position, so that the saw teeth cannot come into contact with the work accidentally. These guards can be unlatched by a motion of the right forefinger, just previous to commencing the cut. A small chute is provided at the rear to carry away all dust. A permanent gauge for positioning the work is secured on the stationary bed. The swiveling table can be locked in any desired positon, and it is possible to lock the saw at any height. The saw is manufactured by the Tannewitz Works, of Grand Rapids, Mich.

Construction work on the new extension to the Port Arthur plant of the Provincial Paper Mills has been started. The cost of this addition will be in the neighborhood of $1,500,000.

The contract for the construction of a cooling plant for Swift Canadian Packing Co. of Ottawa, has been awarded to Joseph Robert at an approximate cost of $10,000.

Refrigeration For the Power Plant Engineer

This Article, the Second of a Series of Six, Explains the Principle of the Compressed Air Refrigerating Machine, Taking up Heat and Rejection of Heat at Different Temperature Levels

By T. H. FENNER

WE HAVE seen that in order to change the state of a body, or a gas we must either give up or absorb a certain amount of heat, which is partially made up of sensible heat, which effects the change of temperature necessary to bring the body to the point of fusion. The remainder of the heat given up or absorbed has no effect on the temperature, but is latent in the body or matter or gas.

If we place a block of ice in the ordinary household refrigerator, the ice being at a temperature of 32 degrees, and the refrigerator at say the temperature of the room it is in, which may be considered at 70 degrees, the ice immediately begins to take up heat from its surroundings. These include the air in the refrigerator, and the contents. Suppose the block of ice weighs 50 lbs., then in order change it into water at 32 degrees, we shall have to absorb from the refrigerator contents 144 x 50 7200 B. T. U. If we consider the contents as dropping to 32 degrees, that is 38 degrees of temperature drop, there would be enough heat absorbed by the ice to cool 188 pounds of matter to 32 degrees. We know that the 50 lb. block of ice will not produce such results. Why? Simply because as soon as the inside of the refrigerator becomes at a lower temperature than the air in the room, heat starts to infilrate through the walls of the refrigerator itself. This heat has to be taken up by the ice and this adds an appreciable amount to the total heat. In other words while the ice is absorbing the heat in the refrigerator, more heat is being added to it by infiltration. Every time the doors are opened to take out food or place fresh food in, there is a fresh accession of heat, which raises the temperature. These losses are variable and hard to compute. If we had perfect insulation, and double doors that would minimise the amount of heat getting into the "frig." every time it was necessary to place or remove food, we should get a considerably larger amount of cooling effect from our block of ice.

Now if we could keep adding just the amount of ice necessary to counterbalance the heat infiltration, we could keep our refrigerator at the same temperature indefinitely. That is not possible, but if we can use some other means instead of ice, such as a cold liquid and keep it circulating through the frig., taking the accrued heat out of it at each cycle of revolution, and sending it back again to absorb heat again, we would have the desired result. This is exactly what is done by a mechanical refrigerating machine. The cold liquid gives up its heat to the refrigerating medium which is in the form of a liquid, and which is changed to a gas by the absorption of heat from the cooling medium. This heat is taken up by the cooling liquid from the air or goods that have to be cooled, and the cycle of heat rejection and absorption continues as long as the machine is running. In many cases the gas itself is the direct medium for taking up and rejecting heat, and in order to understand how this is possible we shall consider the matter in more detail.

The Air Machine

Outside of early machines which employed the absorption of heat caused by chemical mixtures, the first commercial machines were those that employed the compression and expansion of air. The machine in general consisted of a steam cylinder which furnished the motive power. In connection with this steam cylinder were two air cylinders, driven from the same crank shaft, or in some cases arranged in tandem, which were used for the compression and expansion of the air. These two cylinders were fitted with ordinary slidevalves, arranged to cut off at a definite point of their stroke. The first or compression cylinder was of much smaller diameter than the second or expansion cylinder. These cylinders were double acting just as the steam cylinder, and we can consider the action at one end only as illustrating the whole cycle. On the suction stroke of the high pressure cylinder, air was drawn in until the point of cutoff was reached, just as in an ordinary air compressor. On the return stroke this air would be compressed, being raised to a certain pressure and temperature, when the exhaust valve would open, the compressed air passing to the piston of the low pressure cylinder. Now let us see what has taken place so far. A certain quantity of air has been raised from atmospheric temperature and pressure to a pressure and temperature considerably above the atmosphere, by reason of the work performed on it in compressing it. Here we have the work appearing in the form of heat in the air. The high pressure cylinder being surrounded by a water jacket, a certain amount of the heat would be carried away by the circulating water, sufficient to prevent the cylinder walls from getting to an unworkable heat. On leaving the high pressure cylinder still at fairly high temperature, the air passed round another coil in which water was circulating, still more of the heat being carried off by the water of this coil. The air on reaching the chest of the low pressure cylinder would be then at approximately the same pressure as it had when leaving the high pressure cylinder, but at a temperature considerably less than that due to its pressure. It is then admitted to the cylinder, and when a certain portion of the stroke has been made the slide valve closes. The air then expands for the remainder of the stroke, doing work on the low pressure piston and in doing so it gives out about the same amount of work as has been done on it in the compressing cylinder. This means that it gives up about as much heat as was given to it by the work done, but as the heat of compression has been carried away by the circulating water, and the air in the low pressure cylinder is at about atmospheric temperature at the beginning of expansion, its final temperature is a great deal lower than that of the atmosphere. This cold air is then discharged from the cylinder and conducted through pipes to the rooms to be cooled. These being at a higher temperature than the air in the pipes, heat is absorbed from the rooms, and is carried away by circulating air, which goes back to the high pressure side to be passed through the cycle again.

Now this is the cycle in any refrigerating machine. Heat is added to medium at one stage of the cycle, it is rejected at another, and in the third an amount of heat equal to that rejected is taken up again. But, some reader will say, this brings us back to where we started. This is an assumption which may easily be made but a little further examination will show where it is wrong. If the addition and subtraction of heat were made at the same temperature level, this would be quite true. Let us take our air machine again. Air at atmospheric pressure and temperature has work performed upon it which increases its pressure and temperature. The work necessary to overcome the internal resistance of the air to compression is absorbed in the air, while the remainder of the work appears in the form of a high temperature. This heat is carried away in the cooling water, leaving the air with an amount of heat about equal to its initial temperature plus the heat due to the work of overcoming the internal resistance of the air. If this air were allowed to expand slowly to its original pressure, the amount of heat that was taken up by the air itself to compress it would be sufficient to accomplish the work of expansion. However the air in expanding is allowed to do work on the piston and this work is equivalent to a certain amount of heat. This heat is taken from the temperature of the air, which results in the temperature being lowered considerably. When the cold air passes to the room to be cooled, it takes up heat, but this heat that is added only

somewhat lower than the temperature of the room. Thus we see we have added heat first at high temperature, rejected heat at high temperature to the circulating water, and then given up heat by doing work, causing a further drop in temperature, and finally have again taken up heat at low temperature.

Internal Work

As a simple illustration of what is meant by the internal work absorbed or given out in overcoming internal resistance of a gas to be compressed we may take the familiar case of steam raised from water at 32 degrees to atmospheric pressure. If we take one pound of water it will occupy a volume of 1-62.5 part of a cubic foot. Steam at atmospheric pressure requires a volume of 26.36 cubic feet. Suppose we have one lb. of water in a vessel one square foot in area, and 26.36 feet high, the water being at a temperature of 32. Let the pressure of the atmosphere on the surface of the water be represented by a frictionless piston, having a weight equal to 147 lbs. per sq. inch. When the water has been evaporated to steam at atmospheric pressure the vessel will just be filled, and the piston will have been raised from a height of .016 feet, the level of the surface of the water at the beginning to a height of 26.36 feet. If the piston weighs 14.7 lbs. the work done is the product of the resistance overcome by the distance, or 14.7 x 144 26.36. The height of the water .016 feet is so small a fraction of the total that it can be neglected. The work done is then 55,-799 ft. lbs. and this divided by 778 gives 71.72 B. T. U. as the heat required to overcome the external resistance or the resistance of the atmosphere. Now the total heat units expended have been 1.146 B. T. U. 180 to raise the water from freezing to boiling point, which sensible heat, and 966 B. T. U. latent heat. In overcoming external resistance we have expended 71.72 B. T. U.

We have therefore the following distribution of heat in evaporating one pound of water from 32 to steam at 2.12 degrees.

Raising temperature of water 180 B. T. U.

Overcoming internal resistance 894.28 B. T. U.

Overcoming external resistance 71.72 B. T. U.

ANOTHER SUGGESTION

Editor, Power House:—

I have read with interest all letters regarding "The Dominion Certificate," and also the suggestion of C. T. M. of March 20, 1922. I really believe that C. T. M. is asking the government too much in asking them to give every holder of a certificate a "Dominion Certificate" of the same grade. I have been employed at different places and have been in contact with a good many engineers, and I could not see for the life of me how some of them ever got a First or Second Class certificate. If these same men had to sit over again perhaps they could get a third and perhaps not. Examinations in the olden days, (as we all know), were not what they are today. Then if we do approach the government, suggest to them when they do pass this law to have all engineers sit over again for the "Dominion Certificate." This is also offered as a suggestion.

Editor's Note

This question is one on which there would naturally be very wide diversion of opinion, some favoring the granting of a certificate equal to the one already held, and others feeling that no certificates should be granted except on examination.

We feel in this matter that in the case of men holding positions successfully, the passing of new legislation should not be allowed to work them injury. Common sense insists that if a man has been running a job for a number of years he must be competent, certificate or no certificate. It is different for those just coming up, but it would be a positive injustice to ask a man to pass a theoretical examination, after he has spent a large portion of his lifetime working hard at the practical end of his business without the opportunity of gaining the theoretical knowledge. The object of improved certificates is to improve the general standing of engineers, which can be attained without harming anybody, and should be done in that way if it is to be done at all.

There is one thing which continually bobs up in correspondence, and one which we think should be eliminated, not only from the correspondence, but from the thoughts of the correspondents. We mean the constant repetition of the opinion that the other fellow has a certificate which he should not have. Our correspondent above says, "he does not see for the life of him how they ever got a first or second certificate." The other fellow may have been thinking the same.

We should remember this. A man holding a certificate has complied with the regulations of the authority issuing that certificate. He can do no more. He may be able to pass a much harder examination, on the other hand he may have just scraped through. In the latter case he deserves more credit than in the former, for he has had to put in a good deal more effort.

The thing is this: When we meet a man who is obviously not so well informed as ourselves, let us help him instead of sneering at him. Remember that old fable of the lion and the mouse. Be charitable.

FACTORY INSPECTION

Editor, Power House:—

Having read the article in April 5th issue re factory inspection, I think it about time that the factory inspection department realized that the factory workers of Ontario are entitled to some degree of protection. It is purely criminal the way the factories of this province are inspected. I was employed by a concern where a new plant was built and put into operation and nearly four years passed before a factory inspector showed up, and then he might just as well not have come, for all the good he did. There were a great many things that needed his attention but all of them went unnoticed by him.

What we want are men who are wide-awake to the interest of the people employed in the factories of this province and not men who just merely draw their salaries. As you stated what we want is a department that will inspect. I can assure you that from the many things that have come under my personal notice in different plants I have visited, I think it high time for a change that will give the factory workers of Ontario the protection to which they are justly entitled.

I have the honor to be, yours for a square deal, "Onlooker."

WATER WHEEL CORROSION

In the water wheel work the blades of the wheels travel at very high speeds. The combined effect of the evacuation resulting from this high speed and the corrosive action caused pitting in bronze, this pitting being sufficiently deep to bring about failure. Monel metal replacing such bronze has shown more than 9 years' service without a sign of pitting.

Industrial consumers of coal in Ontario have shown no sign yet that they fear a shortage of bituminous coal, as a result of the strike that has been in progress since April 1. The situation has been remarkably quiet, as regards operators, miners and consumers. The Canadian situation is causing little comment. The general view is that the long notice given to consumers gave them an opportunity to secure adequate stocks, and that there is no occasion for worry for some time yet. The large industrial users of coal in particular have protected themselves against almost any contingency.

Great interest is being shown in the discovery of a new metal, non-ferrous in character, and known as "Virtu." The new material dispenses with electroplating, does not tarnish, and is considerably less than half the cost of stainless steel ware. Experiments are now proceeding in the steel works to decide whether the discovery can be applied for engineering purposes. Exhaustive tests have proved that the material can be rolled or cast. The inventors are hoping to prove that it can also be forged or hot rolled like steel, in which case it could be applied to a hundred-and-one uses in constructional trades, as, for instance, turbine blades, agricultural machinery parts, and motor-car fittings, which are particularly liable to corrosion through exposure.

Practical Electricity For the Engineer

By G. R. ARCHDEACON, A.M.I.E.E.

AS ALREADY explained in the last chapter, current density is always expressed in "amps per sq. inch."

Many different strengths of current may be sent through the conductor of a certain sectional area. This current, or rather electricity, may (for practical purposes) be said to permeate the substance of the conductor, and the greater the current value, the higher will be the "current density."

It must now be clearly understood that this question relates solely to the current in the conductor, and in no way does it relate to the pressure, or voltage at which the current is being "forced" through the conductor.

When a given current has to be carried, the conductor must be of such a size that the "current density" does not exceed a certain number of "amperes per sq. inch." The reasons for such limits are as follows:—

(a) The greater the "current density" in a given conductor, the greater the amount of heat that will be generated in the conductor.

(b) The greater the "current density," the greater the "loss of pressure" or "loss of voltage" with consequent loss of power.

From a consideration of the above reasons it will be apparent that in distributing current, it is necessary to carefully calculate the most economical "current density." Thereby permitting the choice of the smallest size in wire, consistent with value of the amount of power lost in that wire. It will be readily seen that it is possible to choose a conductor with such a sectional area that the amount of power lost per annum would be almost zero. The extra cost of such a conductor would be so much greater than a reasonable loss in power would involve.

The marine engineer has to find the "economical speed" of his ship and contrive to keep her running as near that speed as possible. Similarly so has the power engineer to calculate the "economical size" of his cables for distributing his electric power.

The late Lord Kelvin established a law governing these conditions, which is usually accepted amongst electrical engineers.

"The most economical size of conductors is that for which the annual cost of interest and depreciation is equal to the cost of energy dissipated in the conductor."

In other words, every unit of electrical power has cost a certain sum of money, and the amount of the cost of the electrical power lost in the conductor per annum, should just amount to the value of the annual depreciation allowance on that conductor, plus the amount of interest payable on the cost of the conductor.

If the conductor is "overloaded" there is a great increase in temperature, which may result in the burning of the insulation, or even melting of the conductor itself.

In this connection it is very important to bear in mind that the rate of generation of heat is proportional to the "current squared multiplied by the resistance."

Voltage Drop Round a Circuit

As in the case of steam or water there is always a loss of pressure in the various conductors, and so in any electrical circuit the volts drop in value round the circuit.

It is important that this fact is not overlooked, otherwise in laying out a scheme for lighting some workroom a distance from the power house ,the "drop in volts" may be so great that the resultant illumination from the electric bulbs will be so reduced as to be merely darkness visible.

Suppose we consider a circuit which has a difference of potential of 100 volts. If we connect a voltmeter across the ends of the circuit we shall obtain a reading of 100 volts, but if both voltmeter wires were brought into contact with the same end of the wire, the voltmeter would register zero voltage, because there would be no difference of potential at that point.

If the conductor of this circuit is made throughout of the same material, and same diameter, the fall of pressure, or volts drop round that circuit will be uniform. Thus, one quarter way round the circuit, the volts on the voltmeter would register 25 volts, half way round 50 volts potential difference.

The pressure falls gradually all round the circuit, if the latter be uniform.

The fall of pressure in any part of a circuit carrying a given current is proportional to the resistance of that part.

Generally we find that certain parts of a circuit have a greater resistance than other parts. Take for example a simple circuit containing a single electric bulb. If we test the voltage across the main terminals of this circuit we find say, 100 volts potential difference across V. Again take a reading across VI and we obtain a difference of potential of about 99.5 volts. (Fig 1).

From this experiment we see that we have actually only lost half a volt along the wire, whilst through the lamp we have lost or caused to be dissipated 99.5 volts. This being due to the fact that practically all the resistance of the circuit is concentrated in the lamp, whilst the resistance of the wires or conductors is practically negligible.

Now connect two electric bulbs in series across 200 volt circuit. And if the lamps are each of the same candlepower and of the same resistance there will be consumed within each lamp 99.5 volts because the length of the circuit will not be sufficient to cause a drop of half

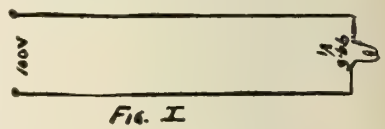


Fig. I

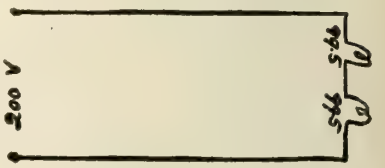


Fig. II

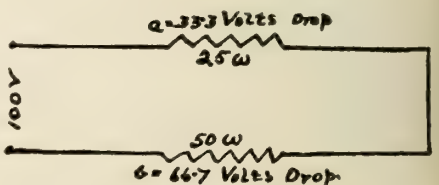


Fig. III

volt. This exaggeration is purposely made to emphasize this point.

The Current in Each Part of a Series Circuit Requires Pressure in Proportion to its Resistance

It will be quite apparent from the above statement that the pressure is consumed in proportion to the amount of resistance, and should this resistance vary along the circuit, so also will the drop of pressure vary in each resistance.

For example let it be supposed that the resistance of the circuit (Fig. 3) is chiefly concentrated at a and b, and that a has a resistance of 25 ohms, and b a resistance of 50 ohms. The resistance of the connecting wires being negligible. The total pressure of 100 volts is thus mainly taken up in forcing the current through the total resistances of 25 ohms plus 50 ohms or a total of 75 ohms.

The pressure drop through the whole 75 ohms is 100 volts.

The pressure drop through a $\frac{25}{75}$ of $\frac{100}{1}$ is 33.3 volts.

The pressure drop through b $\frac{50}{75}$ of $\frac{100}{1}$ is 66.7 volts.

Whenever a Current Flows Through a Conductor There is a Drop of Volts Proportional to the Current and the Resistance of the Conductor

This rule is merely the application of Ohm's Law to a part of the circuit, and may be expressed as follows:—

Volts drop = ohms × amperes.

If the volts drop and the current be known, the resistance can be found:—

$$\text{Ohms} = \frac{\text{volts drop}}{\text{amperes}}$$

$$\text{Amperes} = \frac{\text{volts drop}}{\text{ohms}}$$

Power in a Circuit

When current flows round a circuit containing lamps or heaters, etc., it is sometimes a puzzle that it should be the same at the end as at the beginning of the circuit. Light and heat have been given out, therefore something must have been absorbed.

Something certainly has been absorbed, what is it?

It is pressure that is absorbed in the circuit, especially in those parts which have the greatest resistance, such as where the light or heat is generated.

As already demonstrated the absorbing of the pressure in the circuit is manifested by the voltage drop through these various current consuming devices.

Pressure, however, alone is not sufficient. It is pressure and current which has been turned into light and heat, in other words electrical power. This is the product of the two quantities, volts and amperes and are known as "watts."

Voltage multiplied by amperes equals watts.

The "watt" is therefore the "unit of electrical power," or rate of doing work.

In lighting a lamp or warming an electric heater, work is said to be done, and power is absorbed.

Watts = volts × amperes.

$$\text{Volts} = \frac{\text{watts}}{\text{amperes}}$$

$$\text{Amperes} = \frac{\text{watts}}{\text{volts}}$$

The watt being such a small unit it is frequently necessary to employ a larger unit, this known as the "kilowatt," and is equal to 1,000 watts.

As above stated, electrical power is absorbed in any circuit in doing work but this power is reproduced in the form of light or heat energy and so cannot be considered as lost.

Mechanical power is generally expressed as Horse Power, or h. p.

The relation of the electrical horse power to the mechanical horse power is very simple:—

746 watts = 1 h. p..
1 kilowatt = 1.34 h. p.
1 h. p. = 746 watts.
1 h. p. = 0.746 kw.

To arrive at the power consumed in a circuit there is also another method, providing there is no counter electro motive force, such as obtains in circuit in which there are motors or storage batteries.

This method is to **square the current and multiply the result by the resistance.**

$I^2 \times R$ = watts.

Example:—

What horse power would be required to send a current of 200 amperes through a resistance of 2 ohms?

First Step:—

Find power in watts.

$I^2 \times R$ = watts

200 × 200 × 2 = 80.000 watts.

Second Step:—

Find h. p.

1 h. p. = 746 watts.

$\frac{80{,}000}{746}$ = 107 h. p. (approx.).

In sending this current through the resistance we have calculated the h. p. necessary. Now what has become of that h. p.? It has been dissipated into heat by the warming up of the resistance.

In studying the various problems relating to the energy in steam, the power house engineer has become familiar with Joule's mechanical equivalent of heat. There is a close connection between joules and watts, which must now be considered.

The smallest practical unit of electrical work is the joule, a larger unit is the watt-hour, and a still larger unit is the kilo watt hour.

Multiply watts by seconds to get joules.

Multiply watts by hours to get watt-hours.

Time must always enter into any estimation of work done, or energy consumed. If a circuit absorbs 1 watt for 1 second, we can say that 1 joule of work has been accomplished.

10 [watts for 5 min.= 10 × 5 × 60 secs: = 3,000 joules.

Heat is a form of energy, and if an electric circuit contains no counter electric motive force, (e. m. f.) that is to say, if there is no motor or storage batteries under charge, no electrolytic apparatus, or no inductive effect as with alternating currents, the whole of the electrical energy expended in the circuit will be converted into heat energy. If there is a lamp in the circuit, a small portion of the heat energy will be converted into light.

The unit of heat is the British thermal unit, and is the amount of heat required to raise 1 lb. of water 1 degree Fahr. when at its maximum density.

This quantity may be expressed electrically as follows:—

1 B. t. u. = 1,055 joules.
1 B. t. u. = 0.29 watt-hour.

The heat generated in a circuit may be expressed in B. t. u.'s by the following formula.

Let E = volts. I = amperes t = time in secs:

$$\text{B. t. u.'s} = \frac{E \times I \times t}{1{,}055}$$

It will readily be understood that the B. t. u's required to heat a given quantity of water to a given temperature, much will depend upon the efficiency of the heating vessel, this will depend upon three things:—

(a) The proportion of heat generated which is imparted to the water.

(b) The prevention of loss of heat by the water.

(c) The quickness of generation of heat.

Example:—

It is required to boil 2 quarts of water in 6 mins. If the efficiency of the electric heater is 80 per cent., how much energy will be used? What will it cost if the charge per kw.-hr. is 5c.?

1st Step:—

How many B. t. u.'s are required? Assuming temp. of water 60 deg. Fahr.?

212 deg. less 60 deg. = 152 deg. rise in temp.

Total B. t. u.'s necessary, 2 quarts × 2.5 B. t. u.'s per quart × 152 = 760.

2nd Step:—

Find power required?

Theoretical number of watt-hours required = 760 B. t. u.'s. × 0.29 = 220.

$$\text{Actual watt-hours} = \frac{220 \times 100}{80 \text{ per cent}} = 275$$

If one hour were allowed for boiling it would take 275 watt hours, but it is required that the water should boil in 6 mins. or in 1/10 of one hour.

Therefore watts necessary = 275 watt-hrs.

$\frac{\quad}{0.1 \text{ hour}}$ = 2,750

Cost of boiling will be =

$$\frac{275 \text{ watt-hrs.} \times 5\text{c. per k. w, h.}}{1{,}000} = 1.37$$

As heat is generated in the conductors

conveying the electric power throughout the system, so also does this generation of heat effect the operation of the dynamos and motors used on the system. If the dynamo or motor is overloaded it is shown up by the overheating of the machine, and continued neglect of this warning will result in the burning out of several coils on the windings of the machine.

The conversion of mechanical power into electrical power by a dynamo or of electrical power into mechanical power by a motor, cannot be effected without some loss of power in the machine.

Such loss depends upon the efficiency of the machine. The efficiency of a dynamo or motor is the ratio of the power given out to the power absorbed, and is usually expressed as a percentage.

$$\text{Efficiency of dynamo} = \frac{\text{Electrical power developed} \times 100}{\text{Mechanical power required to drive it.}}$$

$$\text{Efficiency of motor} = \frac{\text{Mechanical power developed} \times 100}{\text{Electrical power required to drive it.}}$$

$$\text{Efficiency} = \frac{\text{output} \times 100}{\text{input}}$$

$$\text{Output} = \frac{\text{input} \times \text{efficiency}}{100}$$

$$\text{Input} = \frac{\text{output} \times 100}{\text{Efficiency}}$$

The efficiency of machines varies with their size, small dynamos and motors are less efficient than large ones. The efficiency of a very small motor may only be 60 per cent., whilst large ones sometimes exceed 90 per cent.

Example:—

500 electric bulbs are required to light a factory, each one taking .25 amp. If combined efficiency of dynamo, and distribution is 86 per cent. efficient, what h. p. will be required to drive the dynamo. Voltage being 100 volts.

Total current required =

.25 amp. × 500 = 125 amps.

Total power required =

125 amps × 100 volts = 12,500 watts.

Total h. p. required =

$$\frac{12{,}500 \text{ watts}}{746} = 16.75 \text{ h. p.}$$

Total h. p. required to drive the dynamo.

If 16.75 h. p. = 86 per cent. of the power put into dynamo.

Let X = the power required to drive the dynamo

Then 86 : 100 : : 16.75 : x

$$\text{Then } x = \frac{100 \times 16.75}{86} = 19.47$$

Total h. p. required to drive the dynamo = 19.47 h. p.

THERMALLY ACTUATED RELAYS

The load capacity of any piece of electrical apparatus is determined by the temperature limits of the materials used in the construction of the device. This characteristic sets a definite maximum load which can be applied continuously.

In many cases, this load can be considerably exceeded for short periods of time without danger to the apparatus. In other cases, a succession of short time heavy overloads can be applied without injury, if followed by intervals of very light load, for the heat developed is integrated over a considerable period of time and the temperature attained as a result of successive short overloads is the same temperature as would be obtained if the integrated loading had been applied continuously for the same length of time.

The Squirrel Cage Induction Motor is a typical example. Such a motor takes a rather heavy starting current, especially if it is of small size and is thrown directly on the line without starting compensators. Fuse protection is generally supplied, but in order to take care of the starting current the fuse capacity must be several times normal full-load running current.

This condition results in the possibility of the motor being overloaded to a considerable extent without blowing the fuses and if the overload continues long enough, the motor may burn out. The fuses then only provide protection against an overload sufficiently great to stall the motor.

This condition should be protected against and the thermal relays recently developed by the Westinghouse Electric and Manufacturing Co., are applicable for this purpose.

The theory of protection demands that an instrument be provided which can be connected in electrical circuits, the instrument to have in itself small losses which are converted into heat and the device should be so arranged that its temperature rises in proportion to the current flowing through the circuit and also designed to embody a considerable heat capacity. The temperature in the relay will then follow approximately the temperature of the apparatus to be protected and the relay can be adjusted so that it will open the circuit when a predetermined temperature is reached.

The relay may be arranged with or without a pointer to indicate its own temperature continuously, and, therefore, the temperature conditions of the protected apparatus, thus giving an idea of the amount of load which has been placed on the apparatus and the increase in load which may be safely applied.

In designing the thermal relay it was necessary to obtain a heat sensitive material which would have sufficient power to operate a contact and still accurately follow changes in temperature. A high grade of thermostatic metal was found satisfactory for this purpose. In order to obtain the greatest simplicity of design, this same material is used as the resister or heat developing element as well as the heat sensitive element.

The operating mechanism of the relay consists of a number of sheets of thermostatic metal arranged in series or in parallel and with varying resistance, according to the desired current carrying capacity. A contact is attached to one of the element and is normally held with an initial tension against the stationary contact. At the proper temperature the bending tendency of the thermostatic metal takes up this initial tension and the contacts open, thus opening the holding coil of a small circuit breaker to open the main circuit.

EXTENDED SLEEVE CLUTCH

A clutch that is intended especially for the driving of wood, steel, and cast iron pulleys, gears, sprocket wheels, or such similar parts placed on the sleeve has been recently placed on the market. It consists of but few parts and is very compactly designed. The friction disc is of large diameter, whch permits of a strong uniform grip, capable of fine adjustment. The spider is either keyed to the shaft or held by a hollow setscrew. The clutch can be erected by merely sliding it on the shaft and tightening one screw. No extra collars are required to hold it together, and as it is self contained it is not necessary to compensate for end thrust. In order to adjust the friction it is only required that one nut be turned, which nut automatically adjusts the tension for both the fingers. The clutch is intended to operate under hard usage with little or no wear, and without noise. It may be placed on a line shaft so that it drives directly to a machine without using a countershaft. In this way considerable space and belting are saved. When used as a cut-off coupling, it enables one group of machinery to be stopped without interfering with other groups. It eliminates the nuisance of shifting belts in many cases. The bearing end of the shaft runs in a bronze bushing that is supplied with oil from the chamber around the bearing. It is manufactured in six sizes from 5 to 12 in. in dia. At 100 r.p.m. the horsepower transmitted is from 2 to 13 depending on the size. The sleeves are from 5 to 6 in. in length. The clutch is manufactured by the L. W. Carroll Manufacturing Co. of Batavia, Ohio.

MAKE SURE

If you're saddled with the notion
That you ought to have promotion,
Don't mistake the mere desire for ability
to rise.

Give the subject more reflection;
It may take a new complexion,
When you view your capabilities with
calm, unbiased eyes.

Find out if you're returning
Value full for what you're earning.
First be sure that you've already done
the very best you could.

Perhaps the time you're wasting wishing
Takes your mind from off your fishing;
If you show a pile of sawdust, we'll
believe you're sawing wood.

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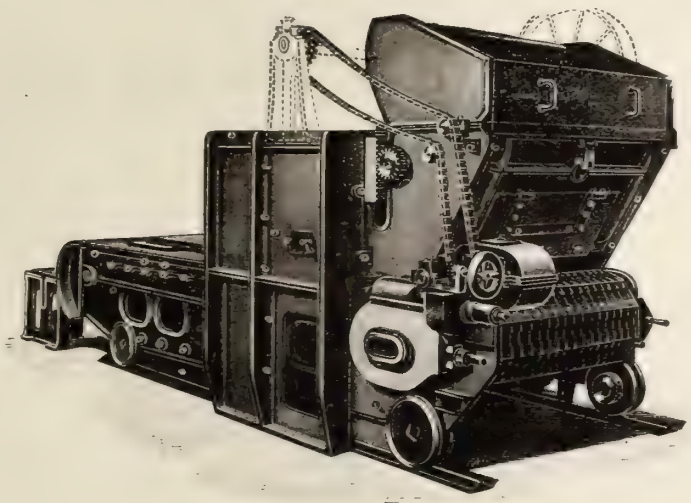

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You can burn cheaper coal than you will handfire successfully as these Stokers are particularly adapted to burn the smaller and poorer grades.

With handfiring it is difficult to get firemen to take the necessary care and to give the constant attention necessary for complete and smokeless combustion. With the B. & W. Chain Grate Stoker the attendant is not required to work so hard or to expose himself continually to the heat of the fire, and he can apply himself to getting economy.

A good fireman can handfire a 200 H. P. Boiler at ordinary rating, but only the skilled and better-paid men can handle overloads. One man can shovel into the hopper of the B. & W. Chain Grate Stokers all the coal necessary for 1,000 Boiler H. P. or he can attend to 2,500 to 5,000 Boiler H. P. where the coal is fed to the hoppers automatically. Over ratings are obtained with little or no extra effort on the part of the attendants.

Combustion rates may be secured with a B. & W. Chain Grate Stoker which cannot be approached by hand firing methods. The increase in efficiency is the result of the even and continuous firing, the constant air supply, complete absence of the necessity of working the fires and the fact that the coal is burned according to the natural laws of combustion.

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Economy of Cork Inserts

By W. F. Schraphorst

Copyright, by W. F. Shraphorst

THIS IS an important topic that has not been written about or discussed to such extent as have other transmission devices. Why this is so is unexplainable. The principal functions of the cork insert is to stop all unavoidable belt slip. In doing this considerable coal and money may be saved.

Thus where 2,000 tons of coal are burned per year where coal costs $9 per ton, and where the over-all belt slip is 8 per cent., the cost of the belt slip in terms of the coal pile is $1,440. To compute the cost of belt slip it is first necessary to find the percentage of slip. That is, if a driven pulley rotates only 95 times, whereas it should rotate 100 times, the percentage of belt slip is 5 per cent or,

$$\frac{100-95}{100}=5 \text{ per cent.}$$

Then multiply the determined per cent. of slip by the number of tons of coal burned per year, and then by the cost of the coal per ton. Thus we have

(2,000 x $9 x .08= $1,440.)

the yearly cost of belt slip.

To arrive at the actual and accurate cost of belt slip is not easy, however. It is plainly more than $1,440 in such a plant as above, because coal is not the only thing that is lost. The belts wear out more rapidly where there is slip than where there is no slip, and the cost of this slip can be approximated.

Let us assume, just for an example that with cork inserts a plant manages to keep its belts a-going for 10 years. The first cost, then, is $500 per year. Without cork inserts the belts wear out in eight years, and the average cost is $625 per year. This would mean a saving of $625—$500, or $1,250 in 10 years. As these figures may not apply to every plant this formula may be used and the reader can substitute his own conditions.

Dollars saved with cork inserts from belt cost standpoint only equal

$$\frac{(Nc - N)\ K}{N}$$

where Nc=life of belt in years with cork inserts;

N=life of belt in years without cork inserts;

K=first cost of belt in dollars.

The cost of lost product must also be considered. The value of cork inserts appears here again, and the problem can be approximated mathematically. Let us take, for example, the above plant where over-all belt slip is 8 per cent. and where the output should be worth, without slip, $2,000 per day. With 8 per cent. slip it is evident that the machines are running 8 per cent. too slow and the product is, therefore, diminished by 8 per cent. Hence the daily output is approximately $2,000—($2,000 x 8%)=$1,840 . instead of $2,000.

To make the formula clearer, and to enforce this cost on the mind of the plant owner, I have thrown it into this form:

Dollars output lost per day=

$$\frac{D}{1-S}-D$$

were D=present daily output in dollars;

S=per cent of belt slip.

Thus, if your present daily output amounts to $1,500, and if your over-all belt slip is 10 per cent, we have, after substituting in the formula

$$\frac{1,500}{1-.10} - \$1,500=\$1,667-\$1,500=\$167.$$

One hundred and sixty-seven dollars lost per day is considerable and may mean the ruin of a small plant, unless discovered and rectified. This "product loss" is often saved by speeding up the driving engines or motors to the extent that after belt slip is deducted the final speed is what it should be anyway. That method is better than none at all, but it is not the best practice. The best practice is to eliminate all belt slip.

Thus comes the cost of defective product. Where belt slip is permitted, the product frequently suffers on that account. The loss cannot be figured mathematically, because it is too uncertain. It may vary from a trifling to a very serious amount. To reduce this loss to the minimum, belt slip must be completely eliminated. By so doing, all machines are driven by steady speeds. There is no bunching here and thinning there. Product is uniform, day in and day out. Such is the ideal state as regards speed, and the value of cork inserts is further emphasized.

A REMARKABLE EXPLOSION

It is often possible, after a boiler explosion, to discover the cause or causes of the accident, says the "Traveler's Standard," but sometimes it is next to impossible to determine why certain boilers do not explode. Inspectors often discover boiler installations that are marvels of ingenuity in certain ways, although the persons who set up the boilers and connected them apparently stopped work upon reaching the stage where it was possible to raise steam, and entirely overlooked the exceedingly essential element of safety. A unique outfit of this kind, which was reported to us recently by one of our engineers who found it while inspecting an elevator on the premises, was bad enough to merit description.

The boiler in this case is a small one of the vertical type (being only 12 inches in diameter and 20 inches long) and is used to supply steam for a hat-cleaning and shoe-polishing establishment on the floor above. It is installed in a basement and is mounted on two wall brackets. Heat for generating steam is supplied to it by means of a large gas burner which is connected to the gas main on the first floor by flexible tubing. The gas shut-off cock is located on the first floor of the building, and is opened to its fullest extent when steam is required, at other times the cock is partly closed, but the gas is supposed to be kept burning constantly during working hours.

The usual method of operating the boiler is as follows: The first thing in the morning, two or three gallons of water are put into the boiler through a branch pipe connected to the main steam line—this branch pipe being equipped with a funnel and a stop valve. After the water has been introduced, the stop valve in the branch pipe is closed, gas is turned on by opening the gas cock on the first floor, and the gas is then lighted at the burner in the basement and left burning with the cock wide open until a steam pressure of from 20 to 25 pounds has been raised. The gas cock is partly closed when no steam is needed, as previously stated.

An examination of the boiler and its fittings showed them to be in a sorry state. The vertical seam of the boiler was leaking badly, but that was a comparatively minor trouble, and perhaps it was a real advantage, inasmuch as it afforded a means by which the boiler could relieve itself to some extent, in case the pressure got too high.

A gauge glass had been provided, but it was so choked with dirt that it could give no indication of the water level in the boiler, and in fact it resembled an iron rod more nearly than it did a gage glass. A spring safety-valve was also mounted on the top of the boiler, but a brick had been wedged between it and the basement ceiling so that it could not possibly operate. The brick was removed, but even then the inspector found it almost impossible to raise the valve. The history of the brick is not recorded, but it can be supplied, with a fair measure of probability, by conjecture based upon a knowledge of how such things go. It is likely that the safety-valve blew off at some time or other in the more or less remote past, and liberated so much steam and water that the flame at the gas-burner was put out. Somebody who happened to be near by detected the odor of escaping gas, and attended to things before any serious result occurred. The brick (as we read the story) was then introduced to prevent subsequent annoyance of this kind—and it certainly was effective.

The proprietor of the hat-cleaning establishment on the first floor was asked how he knew when water was needed in the boiler—the gage glass being entirely useless. He replied that when he opened the valve to obtain steam for cleaning hats, he could tell by the odor whether the steam was dry or not. If it was wet, he knew there was some

(Continued on page 50)

"Tout Passe"

(Everything Changes)

THE FRENCH have a proverb which begins "*Tout passe*" (Everything changes). This contains the germ of an idea which should be good medicine for the business man who is inclined at the present time when trade is quiet to rest on his oars and delay making preparations for the busy period until that period actually arrives.

Everything in this world is continually changing. Some philosophers even tell us that there is no present; there is only the past and the future; the past is gone and to-morrow, even the next hour, the next minute, are in the future. And in the future only one thing is certain, that is, change.

So conservative is human nature that the great majority instinctively assume that whatever conditions exist at the moment must continue to exist for some time to come. The direct contrary is, of course, the case. The philosopher knows that whatever else may happen one thing is certain, viz., whatever is, is not going to continue.

Why is it that only the few can make money in stock exchange speculation? Because the ordinary man waits until prosperous times appear to him to have become established and to have become a permanent institution before he buys. And in most cases he then finds he has bought at the top of the market. On the other hand, when things are at their lowest and he could buy with a prospect or almost a certainty of profit, everything appears to him black and he cannot see any likelihood of change. The shrewd operator, however, knows that when things look at their worst it is time for them to mend. This is the time he chooses for buying and when everything is booming is the time he picks for selling.

We may not be on the eve of a big boom, but one thing is certain, things are not going to remain as they are for long.

Now is the time when shrewd and far-seeing men are preparing for prosperous times. They are making preparations so that opportunity may not take them unawares. They see that now is the time to cultivate trade and make their products known so that when the tide of prosperity is on the flow they may be in a position to take advantage of it and reap the benefit of their foresight.

If anyone tells you we are in for several years of business depression, take heart and be assured that this is a sign we must be nearing better times.

In the spring of 1918 many well-informed men predicted three further years of war. The war ended that autumn.

In 1920 many business men spoke of three or four more years of prosperity. The prosperity wave was even then on its ebb.

These men like the great majority did not realize that everything changes. Are you going to place yourselves among their number, or are you going to rank among the minority and bear in mind the proverb—*Tout passe?*

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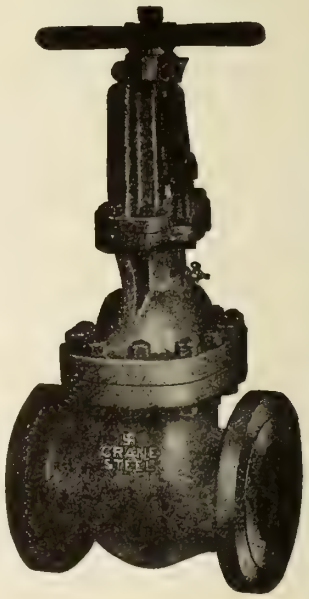

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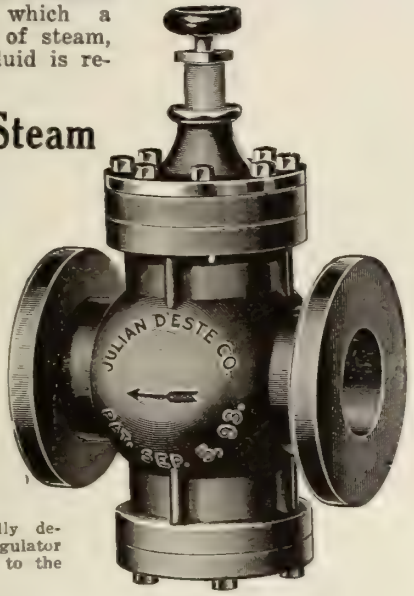

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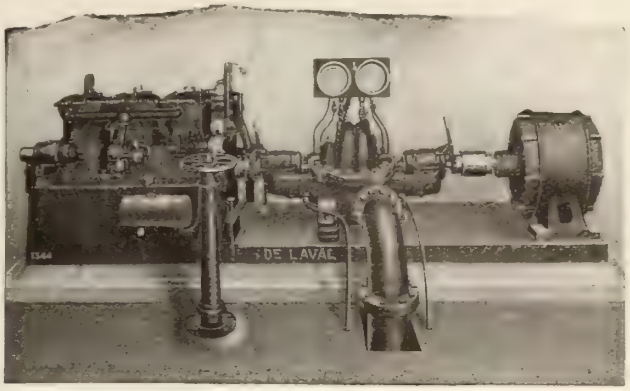

LINDSAY, ONT., SURE OF WATER SUPPLY

THE accompanying photograph shows a combined electric motor and gasoline engine drive for a De Laval two stage centrifugal pump installed by the city of Lindsay, Ont. This unit is guaranteed to deliver 1,325 gal. per min. against 290 ft. head.

The dual drive makes it possible to take advantage of the comparatively low cost of electrical power, with a further saving in attendance charges, and at the same time to have absolute insurance of water supply in case the electric supply should fail. The pump can be connected to either source of power by means of the clutch coupling shown. The De Laval centrifugal pump is simple and reliable. There are no water valves or plunger or piston packings. All working parts are accessible upon lifting the casing cover and can be removed after taking off the bearing caps. Parts subject to wear, such as shaft protecting sleeves, wearing rings and impellers, are made to limit gages on an interchangeable basis, and can be quickly and easily exchanged by ordinary unskilled men.

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Vancouver

225

A REMARKABLE EXPLOSION

(Continued from page 46)

water in the boiler, though he could not tell how much.

Here was a boiler being operated practically without any safety devices—the gage glass choked with dirt, the safety-valve inoperative, and the boiler unattended except at infrequent intervals and in the most casual manner. Yet it did not explode, although other boilers did, elsewhere, notwithstanding the fact that they had been provided with every known safety device, and had received constant and intelligent care. The why of a situation like that is a mystery beyond human ken.

In this case, in addition to the danger of a boiler explosion, the possibility of a gas explosion is ever present, because the boiler is gas-fired and is out of sight of anyone interested in the operation or use of it. The gas flame, when turned low, might be blown out by a current of air, and thereafter the gas would escape into the basement until, if not detected, it would accumulate to such an extent that the stage would be set for a disastrous explosion. An electric motor is installed near by, and the gas might easily be ignited by a spark from this, or by any open flame that it might reach.

On the recommendation of our inspector, the gage glass was cleaned out and the safety-valve was overhauled and set to blow off at a pressure of 25 pounds. He also recommended that the boiler be provided with a proper device for supplying feed water, and that it be removed from the basement and placed in the hat-cleaning establishment, where it could be under constant supervision.

OFFSET SCREW DRIVER

Machine screws that have screw-driver slots in them often present a rather awkward problem when it is desired to screw in or remove them, owing to the location of the screws close to a wall or other projections. To overcome such conditions an offset screw-driver has been designed. Each screw-driver consists of a handle having a square forged end. On the four sides of this squared end are long narrow projections with which the slots of screw heads may be engaged. When using the screw-driver the handle is held at right angles to the axis of the screw. The projection that engages the screw-driver slot on any one side is at an angle of 45 degrees to the projection on each of its adjacent sides. Therefore if a screw is located in a cramped position, after turning the screw as far as space will permit, the screw-driver is given a quarter turn about its own handle axis by the fingers and is again applied. The screw-driver will put in or withdraw screws if only a one-eighth turn is possible. The design also has the added advantage that a considerable leverage can be applied to the screw if necessary. The manufacturers of the offset screw-driver are the Porter Products Corporation of Syracuse, N. Y.

Toronto University is planning the erection of four new buildings and a requisition has been forwarded to the Provincial Government. The plans include a new Forestry building, botany, and Administration buildings, a Woman's building, and additions to the heating plants.

BOOK REVIEW

The "Coal Manual" is the title of a book issued by the National Coal Mining News, Cincinnati, which deals with coal from all the aspects which are of use to a purchaser and user of this universal fuel. In addition to chapters on the analysis of coal, other chapters deal with the efficient burning of coal, and there are instructions to firemen and engineers. The book, which is published at $2.50 in the U. S., should be a valuable one for purchasing agents, plant managers, and engineers in general.

The Victoria Machinery Depot, Victoria, B. C., has been awarded the contract for repair work to the Canadian Pacific car ferry No. 8, driven ashore last month at Porlier Pass and later salvaged by the Canadian Salvage Company. The figure is understood to be in the neighborhood of $50,000. The same firm also has the contract for the overhauling of the C. G. S. Newington, the lighthouse tender operated by the Prince Rupert Agency of Marine. A new tail shaft will also be fitted to the steamer. The Newington is now southbound and expected in a few days at the Upper Harbor yard.

A sliding scale rate which will run from sixty-fie to eighty ents per hour instead of a flat rate basis which is now in effect, will probably be offered to members of the electricians' union of the city. Under the present agreement which expires May 1 the men received 80 cents an hour.

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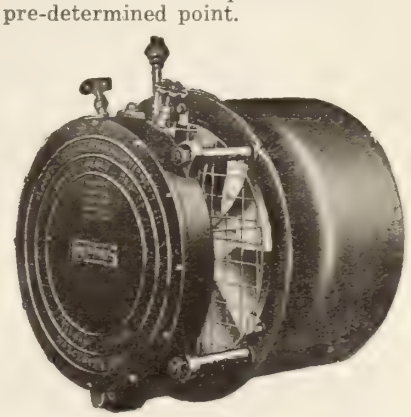

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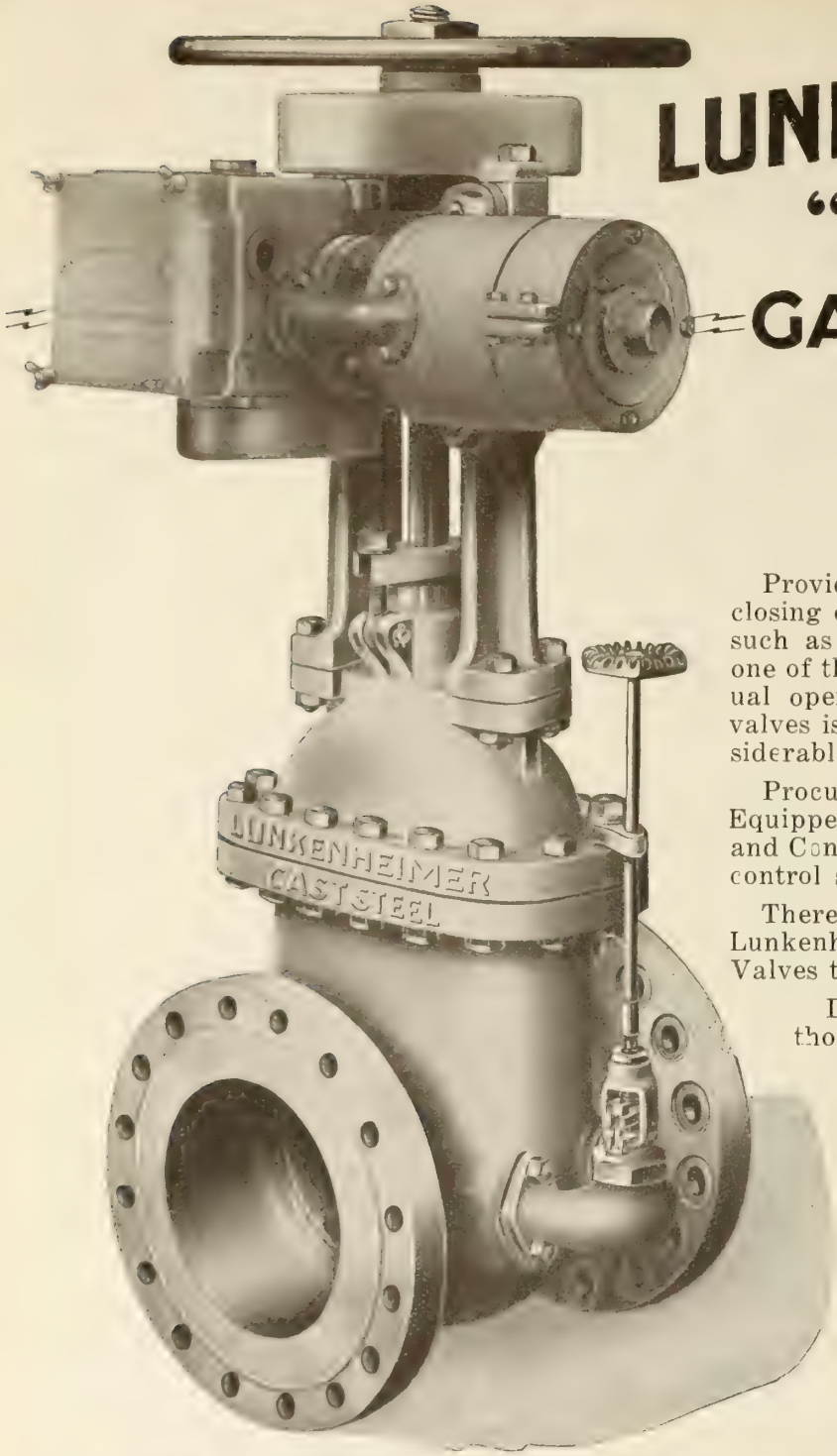

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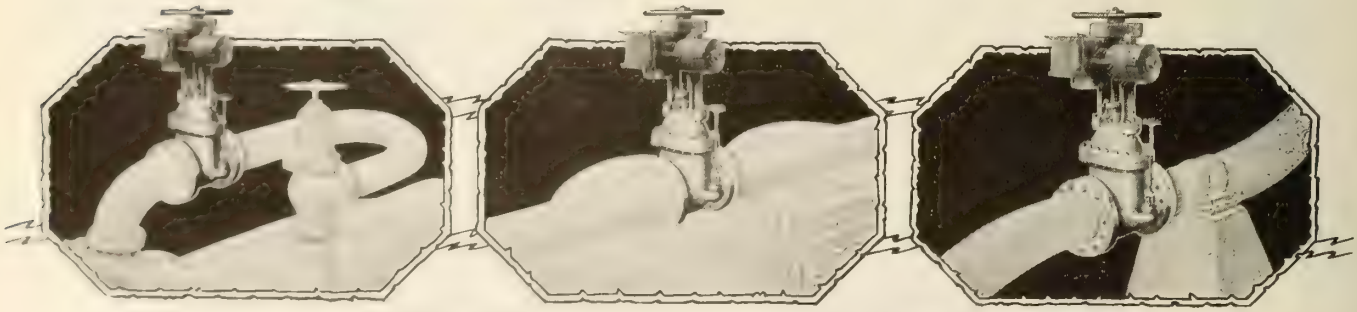

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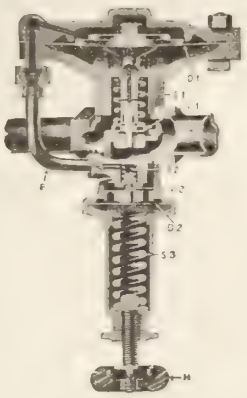

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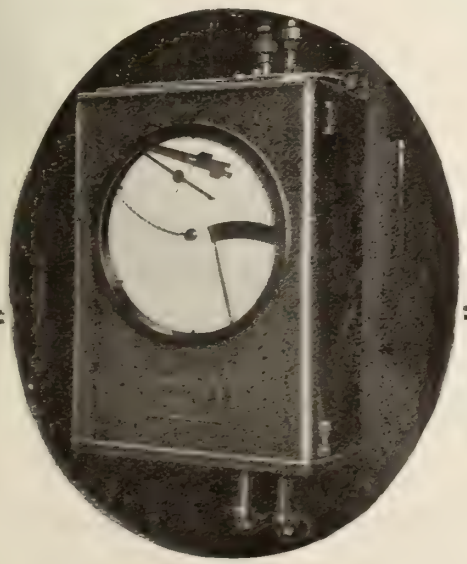

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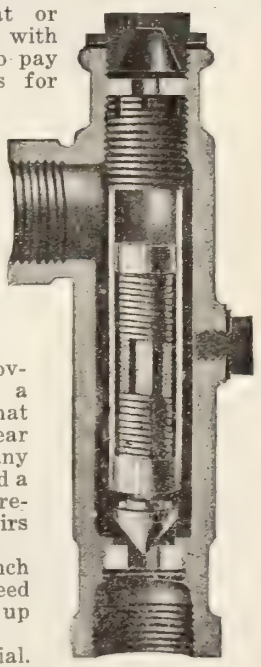

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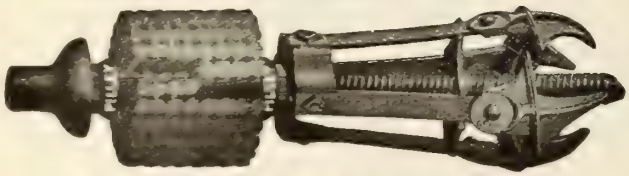

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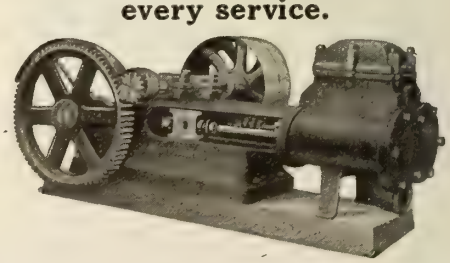

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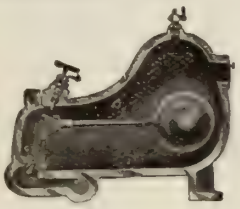

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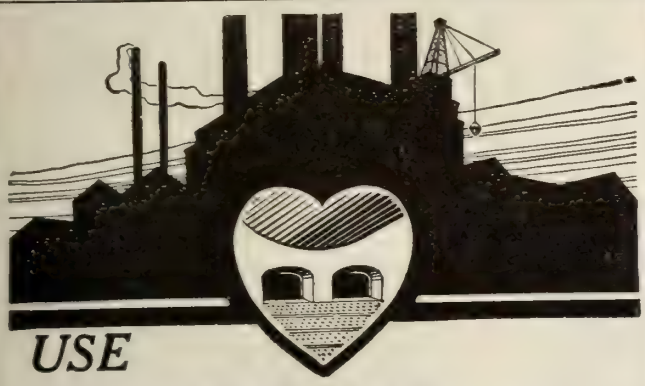

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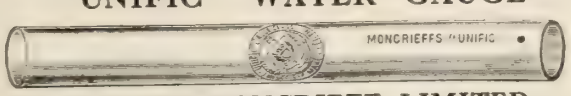

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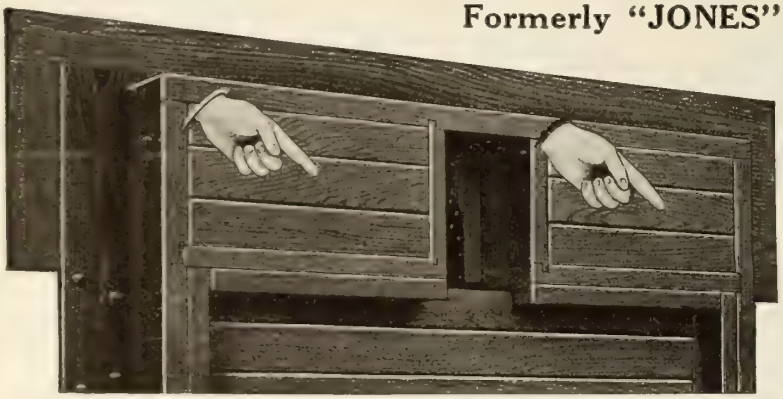

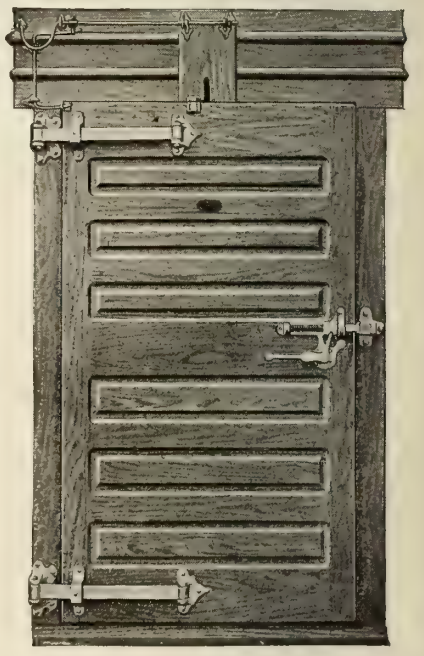

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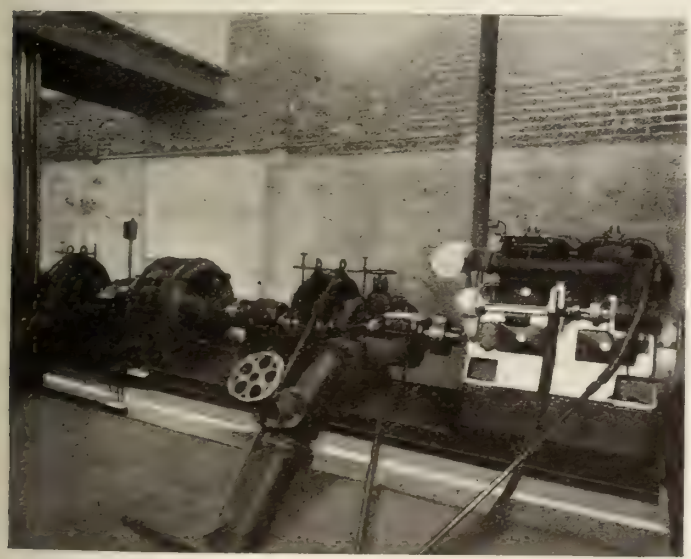

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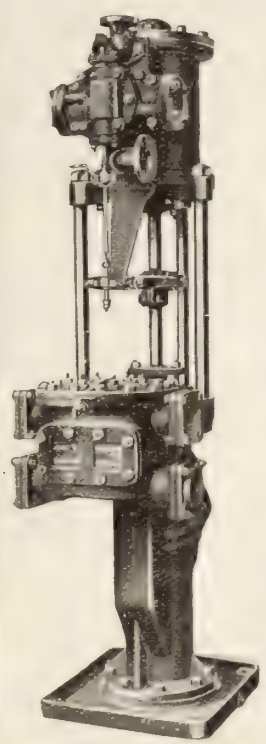

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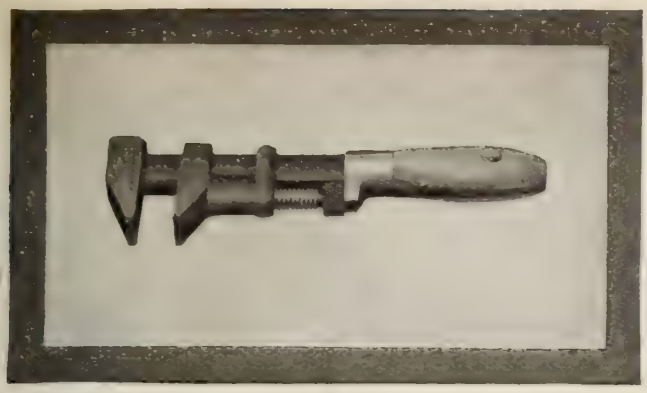

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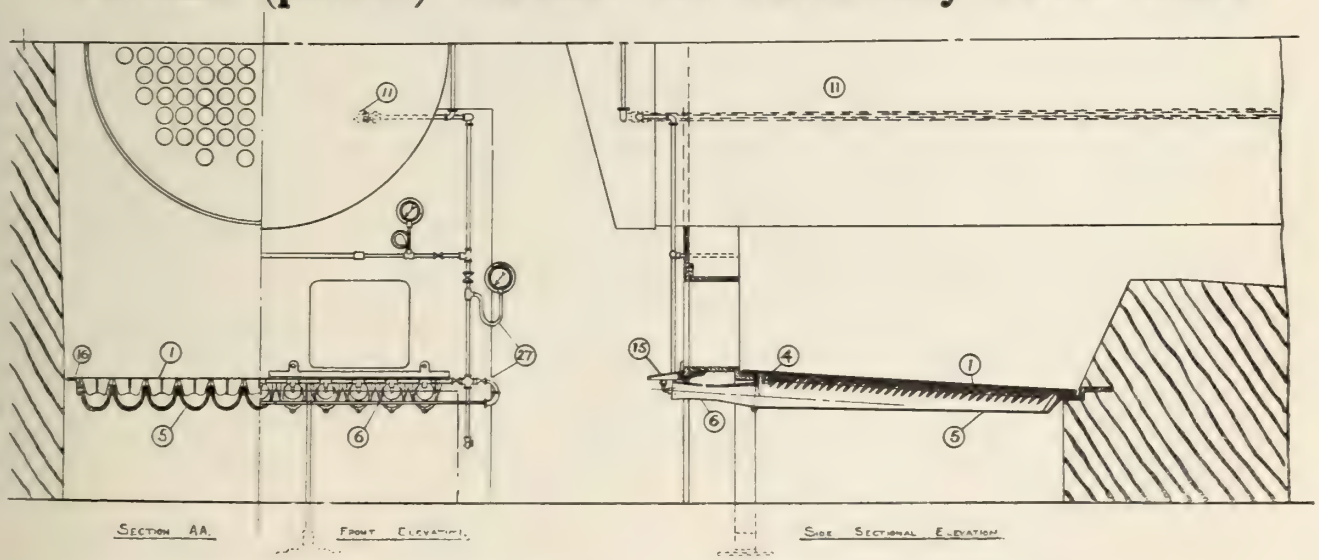

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Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.

PIPE COILS
Frick Co. Waynesboro Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., [illegible]
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited Montreal.

PIPE STEEL
Boving Hydr. & Eng. Co. Ltd. Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes Ltd., Toronto Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg Co. Toronto.
Lunkenheimer Co., Cincinnati, Ohio
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Work Co. Brantford.

PLUG COCKS
Homestead Valve Mfg. Co. Pittsburgh.
Lunkenheimer Co., Cincinnati, Ohio.

PLUMBING SUPPLIES
Jas Morrison Brass Mfg Co. Toronto

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Waterous Engine Works Co. Brantford

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady Hartford Conn.

PRESSES
Boving Hydr. & Eng. Co. Ltd. Lindsay

PRESSURE REGULATORS
The Fisher Governor Co (Inc.), Marshalltown, Iowa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto Ont.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay
Frick Co. Waynesboro Franklin Co. Pa.

PRESSURE AND REDUCING VALVES
Under-feed Stoker Co. of Canada, Ltd Toronto Ont.

PULLEYS
D. K. McLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullough Co., Galt.
Waterous Engine Works Co. Brantford

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Laurie & Lamb, Montreal
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd. Montreal
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Ltd. Montreal
Darling Bros., Ltd., Montreal Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto
Leonard & Sons, Ltd., E., London Ont
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady Hartford Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, BILGE
Laurie & Lamb, Montreal
Smart Turner Co., Hamilton, Ont

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

PUMPS (OIL AND GASOLINE) CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton
Waterous Engine Works Co. Brantford

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady Hartford Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb Montreal
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Smart, Turner Co., Hamilton, Ont.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass
Smart-Turner Machine Co., Hamilton
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co (Inc.), Marshalltown, Iowa

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co. Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
The John H. McGowan & Co., Cincinnati, Ohio
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co, Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co. Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd. Montreal
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

PUMPS, VACUUM
American Steam Pump Co. Battle Creek
Goldie & McCulloch Co. Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto Ont
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford Conn.
Smart-Turner Machine Co., Hamilton

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall Waring Co. Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's Limited, Montreal

RADIATOR TRAPS
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co. Windsor, Ont

RADIATOR VALVES
Lunkenheimer Co., Cincinnati, Ohio

RAGS
Shell Bar Boico Supply Ltd., Toronto

RAILWAY OIL STORAGE AND HANDLING SYSTEMS
S. F. Bowser Company Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co. York Pa.

RECEIVERS, AIR
MacKinnon [illegible] Sherbrooke

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company Ltd. Toronto

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Canadian Johns-Manville Co. Ltd., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS CO2
Sarco Company Inc. New York

RECORDING THERMOMETER AND GAUGES
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Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Taylor Instrument Co., Toronto, Ont.

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REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REFUSE DESTRUCTOR
Laurie & Lamb Montreal.

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Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa
Crane's Limited, Montreal.
D'este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Toronto, Ont.

REGULATING VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

RETORTS
MacKinnon Steel Co., Sherbrooke Que

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

ROLLS, CRUSHING
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RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto

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Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont

SCREENING MACHINERY
Can. Link-Belt Co., Toronto Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Mason Reg. & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAKING BARS, ARCHES, ETC.
Sanford Riley Stoker Co., Worcester, Mass.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co. Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto Toronto.

EXPANSION ENGINES SINGLE, COMPOUND AND TRIPLE
Laurie & Lamb, Montreal

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Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co. Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co. Ltd., Montreal

SOAP, POWDER
R. C. Miller Oil & Supply Co. Ltd., Montreal

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Canadian Planet Engineering Co., Ltd., Windsor, Ont

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co. Toronto Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co. Brantford.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

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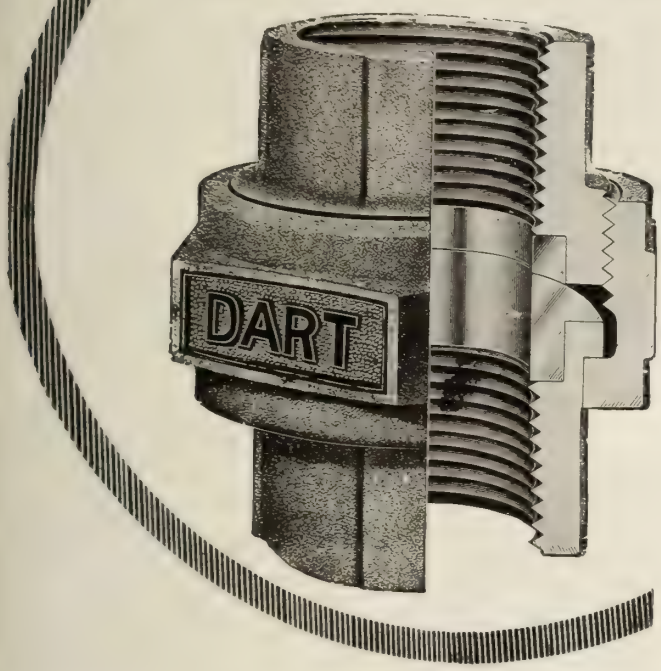
The kind that leaves no room for complaints and saves time



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Goldie & McCulloch Co., Galt.

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Can. Farnsworth Co., Toronto.
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D'Este Co., Julian, Boston, Mass.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
Mason Reg. & Eng. Co., Ltd., Montreal.
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Watson & McDaniel Co., Philadelphia
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Scaife & Sons Co., Wm., Pittsburgh, Pa.

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MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Canadian Planet Engineering Co., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Green Engineering Co., East Chicago, Ind.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co. Worcester, Mass

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Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co. Pittsburg, Pa.

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The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goodie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal

SUPERHEATER, STATIONARY
The Superheater Co., Ltd., Montreal

SUPERHEATER, LOCOMOTIVE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM SHOVEL
The Superheater Co., Ltd., Montreal.

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Canadian Johns-Manville Co. Ltd., Toronto

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SYPHONS
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Penberthy Injector Co. Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay
Canadian Johns-Manville Co. Ltd., Toronto.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal
Waterous Engine Works Co. Brantford

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
B. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay
B. F. Bowser Company, Ltd., Toronto.
Goodie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co. Brantford.

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Wm. B. Scaife & Sons Co., Pittsburg, Pa.

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Goodie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

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S. F. Bowser Company Ltd., Sherbrooke.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Goodie & McCulloch Co. Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co. Brantford.

TECHNICAL BOOKS
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Schaeffer & Budenberg Mfg. Co., Brooklyn.
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THERMOSTATS
Sarco Co., Inc. New York N.Y.

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MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Ltd., Montreal.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
Arthur S. Leitch Co., Ltd., Toronto.
J. T. Long, 84 Adam St, Montreal, Que.
Mason Regulator & Eng. Co., Montreal
Sarco Co., Inc., New York, N.Y.
Watson & McDaniel Co., Philadelphia.
Taylor Instrument Co., Toronto, Ont.

TRAPS, STEAM AND WATER-LINE
Mason Reg. & Eng. Co., Ltd., Montreal.
D'Este Co. Julian, Boston, Mass.

TACHOSCOPES
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.

TRAPS
Canadian Sirocco Co., Ltd., Windsor, Ont.

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Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

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Can. Fairbanks-Morse Co., Montreal.
Victoria Foundry Co. Ltd., Ottawa.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing and Flue Brush Mfg. Co. St. Louis, Mo.

TUBE CUTTERS
Babcock & Wilcox, Ltd., Montreal.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

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Mason Reg. & Eng. Co., Ltd., Montreal
B. F. Sturtevant Co., Boston, Mass.

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Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
MacGovern & Co., Inc., Montreal, Que.

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
B. F. Sturtevant Co., Boston, Mass.

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Crane Ltd., Montreal
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Jas. Morrison Brass Mfg. Co., Toronto.
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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Homestead Valve Mfg. Co., Pittsburg.
Jenkins Bros., Montreal.
Penberthy Injector Co., Windsor, Ont.
Pratt & Cady, Hartford, Conn.
Victoria Foundry Co., Ltd., Ottawa.
York Manufacturing Co., York, Pa
Taylor Instrument Co., Toronto, Ont.

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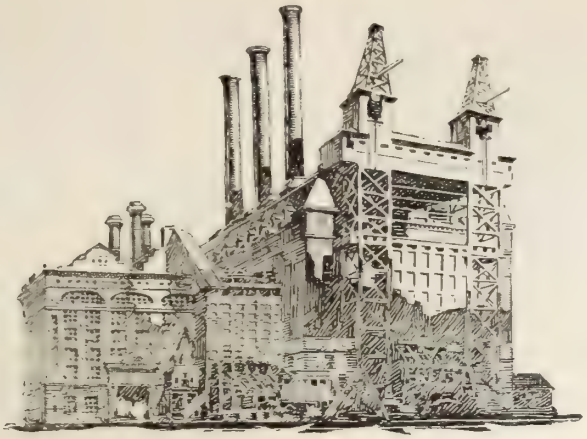

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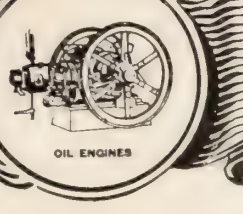

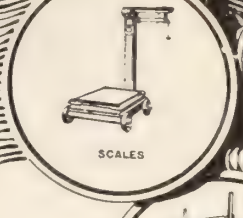

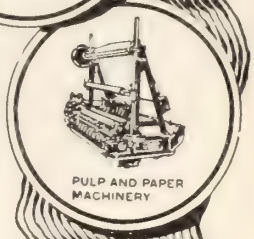

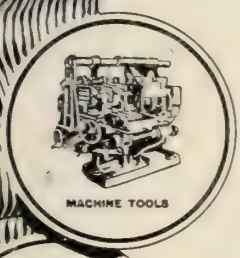

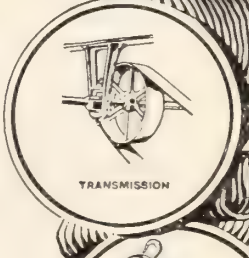

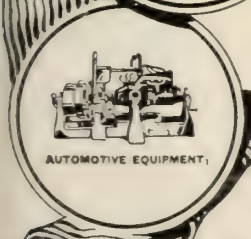

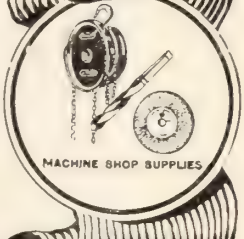

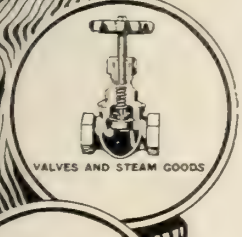

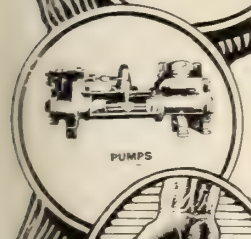

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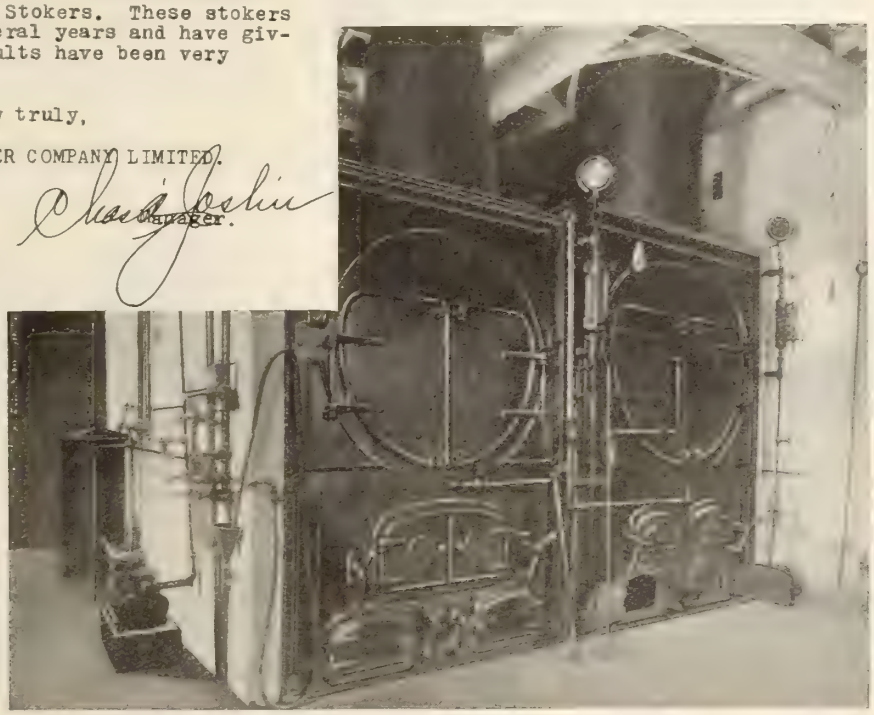

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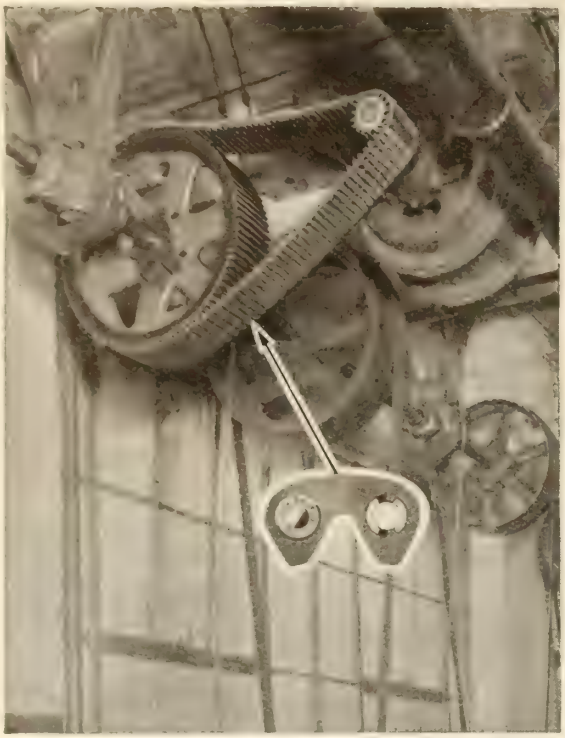

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(Continued next month)

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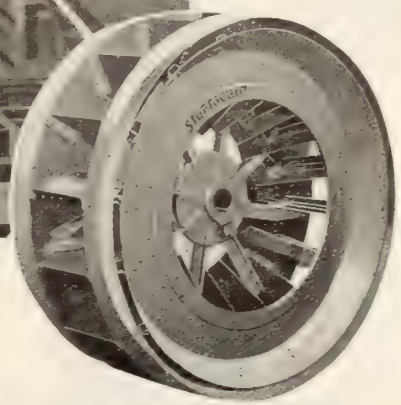

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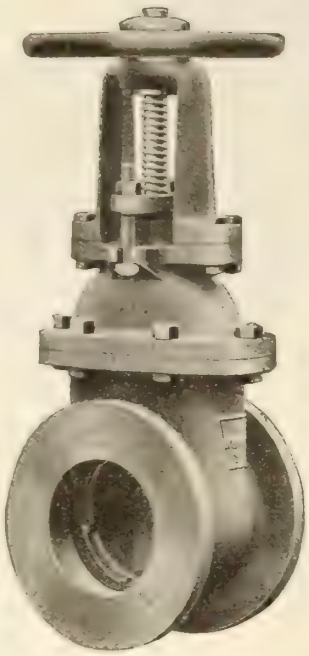

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FOR over forty years we have made a particular study of valve requirements, improving the designs of our products to conform with modern advancement.

This policy, together with the exercise of the greatest care in design and manufacture, is the factor behind the constant repeat orders we receive.

We honestly believe that our new style patterns of valves (notably Iron Body Gate and Swing Check Valves) represent as high a degree of perfection as it is possible to attain.

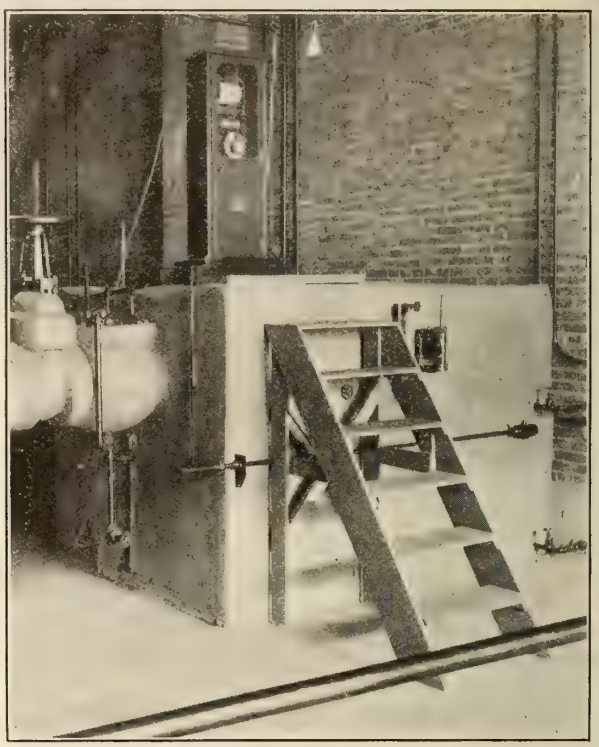
All KERR products are subjected to severe testing before they leave our works and when you purchase KERR products, a KERR guarantee backs the sale.

May we send you a catalogue?

The Kerr Engine Co., Limited
Valve and Hydrant Manufacturers
WALKERVILLE, ONT.

No Guessing Here

This concern KNOWS how many pounds of steam are produced by each pound of coal burned.



Yarway-Lea V-Notch Meter of 400,000 lbs. per hour capacity with temperature recorder, at Utilities Construction Company, Lorain, O.

THE boiler room offers greater opportunities to effect substantial economies and increase efficiency at small cost than any other part of the average plant. More and more executives are coming to realize the prime necessity of **knowing** what results are being obtained—of having some accurate means of checking up on the actual accomplishments. And many of the most progressive are installing YARWAY-LEA V-NOTCH METERS, thereby getting black-and-white records of boiler room operation by correct and dependable measurement.

Among the 2,000 and more modern plants equipped with YARWAY-LEA V-NOTCH METERS is that of the Utilities Construction Company at Lorain, Ohio. They use an extra storage type meter of 400,000 lbs. per hour capacity, in conjunction with an open heater, to measure boiler feed water. A recording thermometer, writing on same chart, gives temperature of water being measured.

Bulletin L-40 contains boiler room information of value to you. We shall be glad to forward a copy at your request.

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7604-20 Queen Street
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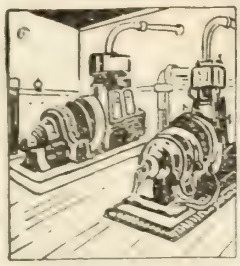

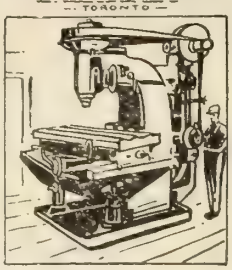

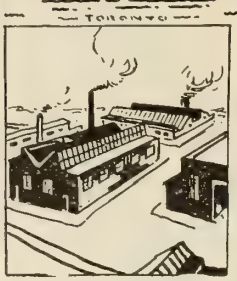

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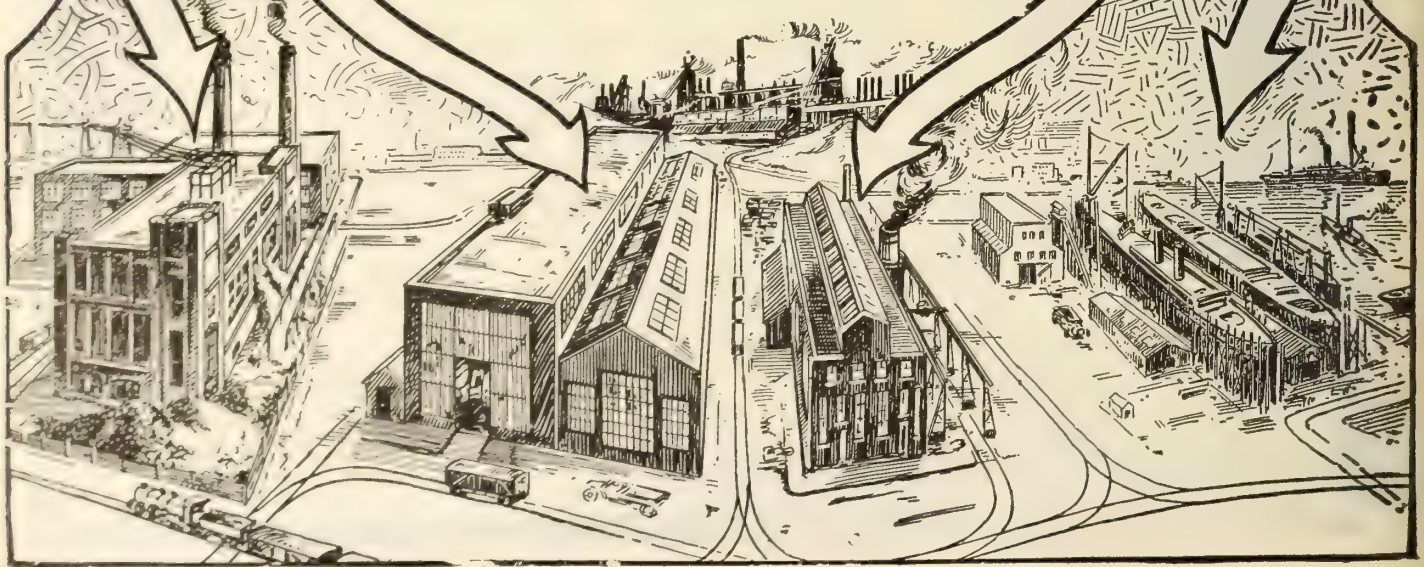

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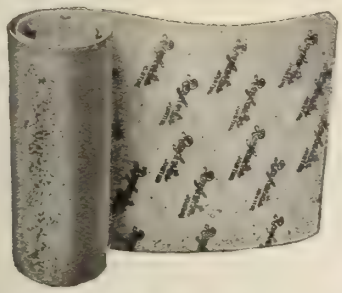

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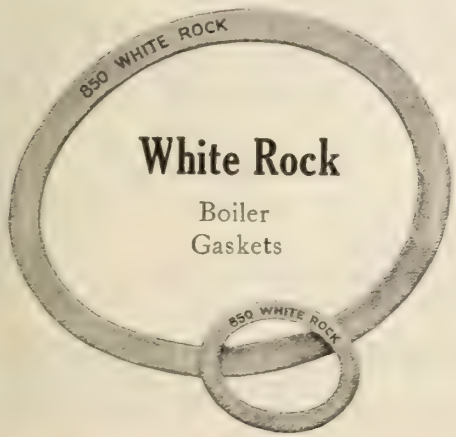

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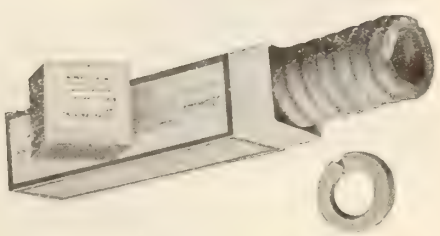

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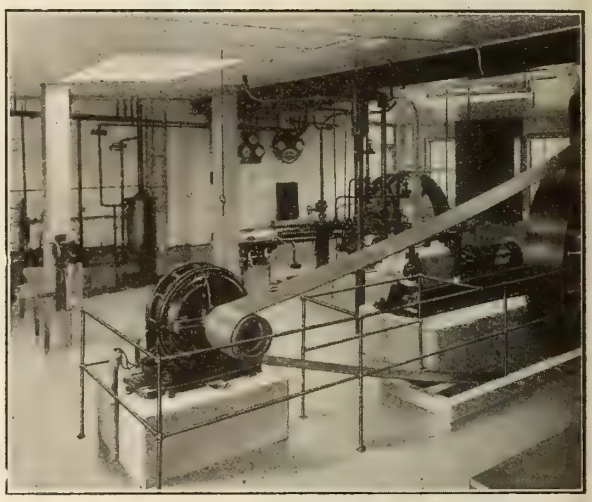

This 100-ton plant was designed by our engineers These men are at your service. Designs, specifications and estimates upon request.

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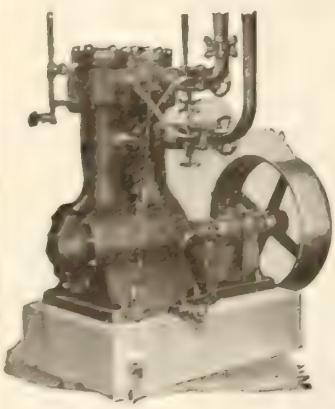

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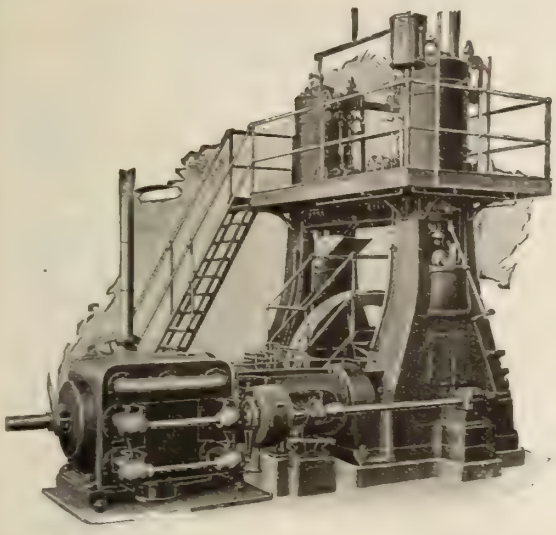

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The York Uniflow Engine, in actual service, has met these requirements most satisfactorily. It is a very economical unit—low in steam consumption under the variable operating conditions encountered in ice making and refrigerating plants, and absolutely reliable under the most extreme of these conditions.

The great range of speed possible with this engine, makes it well adapted for direct connection to York High Speed Refrigerating Machines.

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To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

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Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

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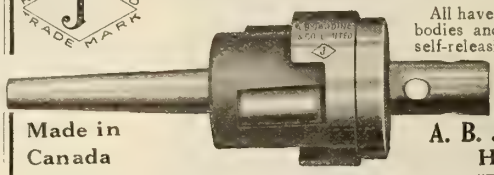
Dealers in power plant specialties, mechanical and hand-fired stokers, valves, steam and vacuum traps, gauges and recording instruments, refrigerating machinery.

Jardine's Self-Feeding Tube Expanders



All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel, it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co. Ltd.
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Jamison HEAVY DUTY Cold Storage Doors *Scientifically Built*

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
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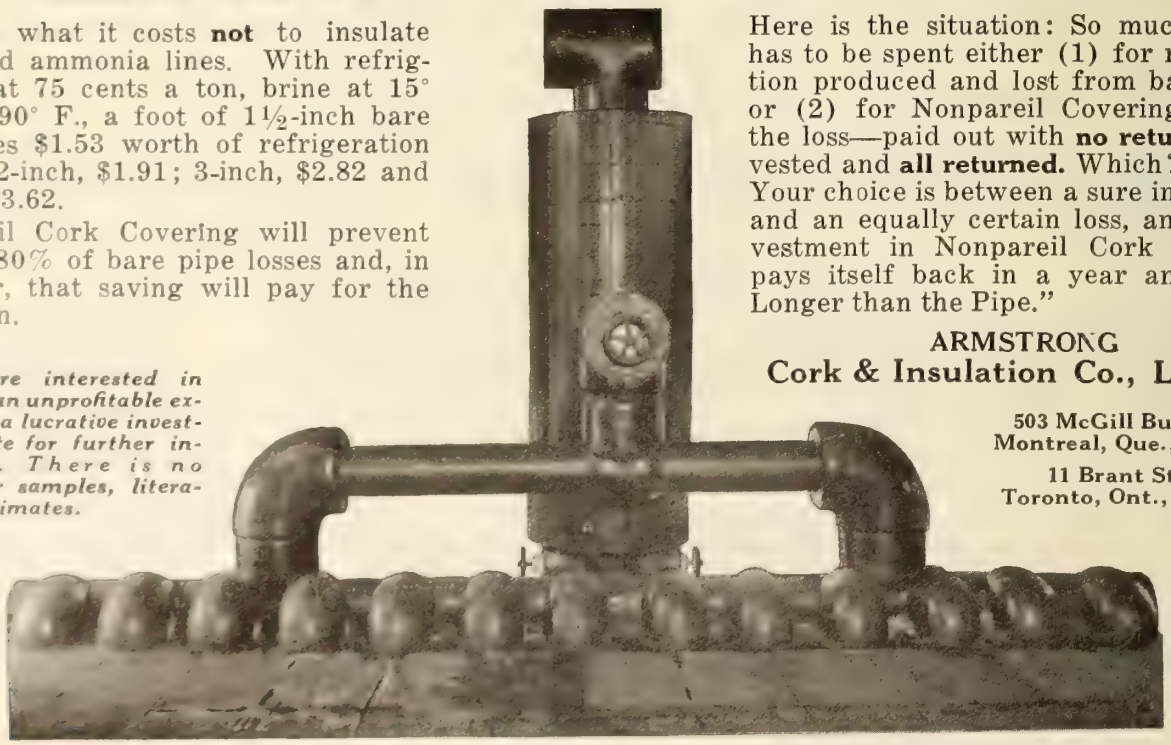
GETTING AT IT BACKWARD

Let's see what it costs **not** to insulate brine and ammonia lines. With refrigeration at 75 cents a ton, brine at 15° and air 90° F., a foot of 1½-inch bare pipe loses $1.53 worth of refrigeration a year; 2-inch, $1.91; 3-inch, $2.82 and 4-inch, $3.62.

Nonpareil Cork Covering will prevent at least 80% of bare pipe losses and, in one year, that saving will pay for the insulation.

If you are interested in changing an unprofitable expense into a lucrative investment, write for further information. There is no charge for samples, literature or estimates.



Here is the situation: So much money has to be spent either (1) for refrigeration produced and lost from bare lines; or (2) for Nonpareil Covering to stop the loss—paid out with **no return,** or invested and **all returned.** Which?
Your choice is between a sure investment and an equally certain loss, and the investment in Nonpareil Cork Covering pays itself back in a year and "Lasts Longer than the Pipe."

ARMSTRONG
Cork & Insulation Co., Limited

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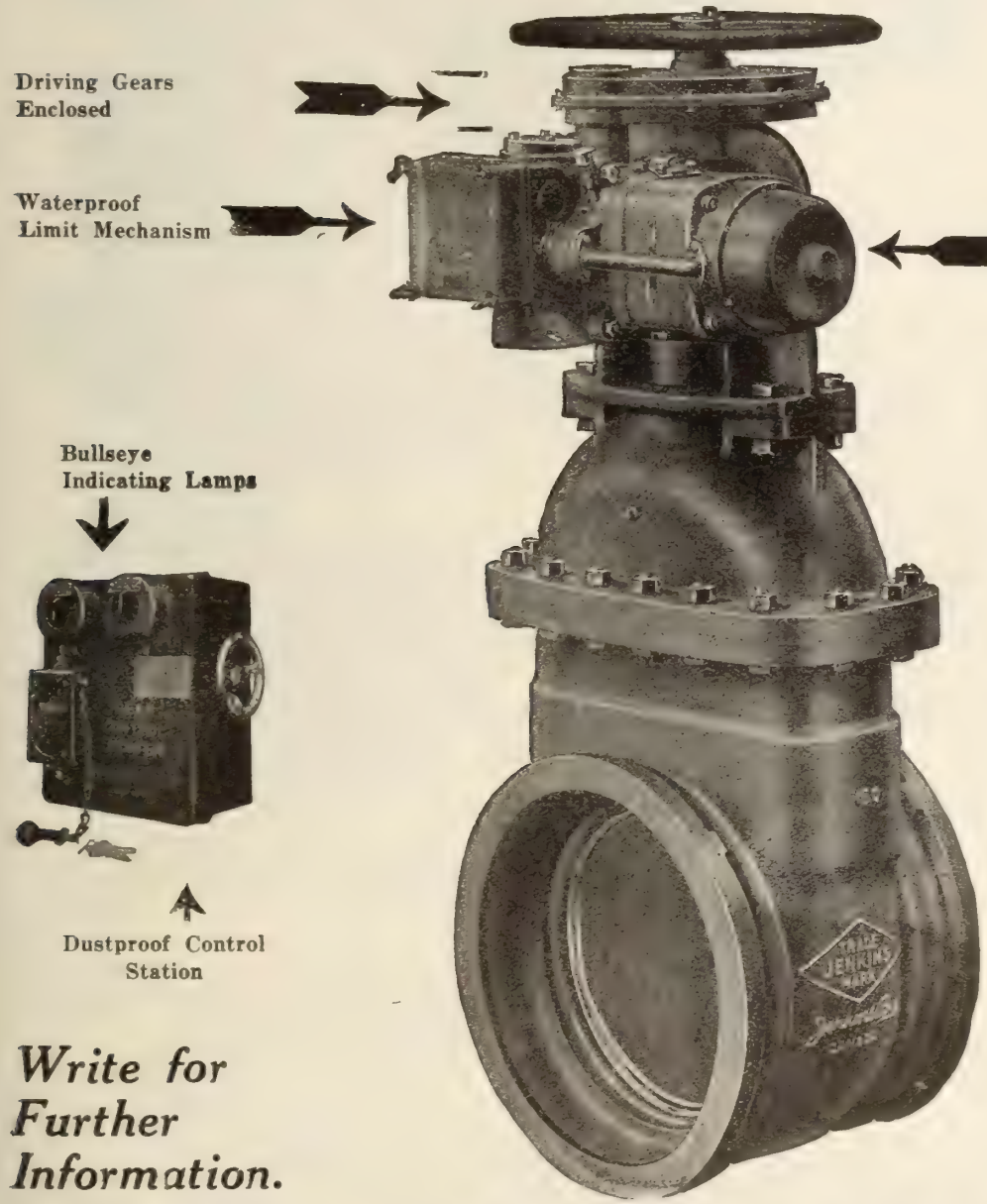
Nonpareil Cork Covering on the ammonia piping, header and accumulator in the tank room of the Bryn Mawr Ice Manufacturing Co., Bryn Mawr, Pa.

Jenkins Valves

Electrically Operated Valves



Outstanding Features:

Adaptable to Inside Screw and Rising Stem Valves.

Positive in Operation. Standardized Equipment with Valve Manufacturers.

Operation from any Electric Circuit.

Short or Long Distance Control.

No Overtravel of Gate. Heavy Unseating Blow.

Designed for any Pressure, Size or Location.

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BRASS GATE VALVES

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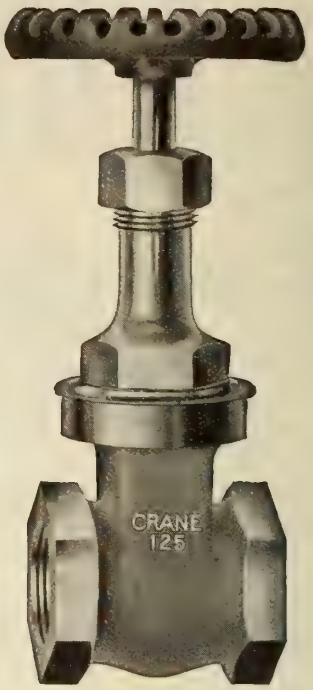

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The Steam working pressure for which they are intended is Cast on the Valve.

Steam Working Pressures up to 125 Pounds.

Cold Water working Pressures, 175 Pounds.

These Valves may be packed when open and under pressure.

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Johns-Manville Anti-Sweat Insulation

A dripping sweat —and the remedy

WE do not always realize the extent of the damage to stored merchandise and goods in process, caused by the sloppy, unsanitary drip of condensed moisture from cold water pipes.

This dripping occurs all along the pipe, slowly damaging everything beneath—even rotting the floor. It is unsightly, expensive, and unnecessary.

Johns-Manville Anti-Sweat Pipe Insulation eliminates this damaging drip and effects a double economy by keeping the liquid in the pipes cold.

It assures really cold water in drinking water systems; and, where cold water is used in manufacturing processes, it cuts the cost of cooling. It is always cheaper to keep water cool than to re-cool it.

Johns-Manville Anti-Sweat Insulation is a combination of insulating and waterproofing felts built up with a broken joint construction that positively prevents air circulation against the pipe. It is highly effective and unusually economical.

Send for a copy of the Anti-Sweat leaflet.

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Through—
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and its allied products
INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
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that save power waste
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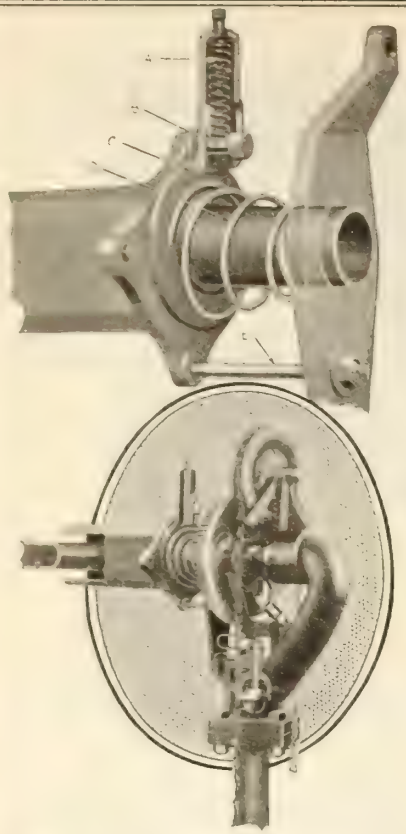
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials



Every boiler needs a mechanical soot blower and you will save money by buying the best. Ask for your copy of Bulletin 287 describing the new blower.

Floating Features of DIAMOND VALV-IN-HEAD SOOT BLOWERS

One of the most important factors in the success of the Diamond Valv-in-Head soot blower is the floating mechanism which provides a means of taking care of any shifting of position of the blower element without causing dislocation of the wall box, cracking of brick work, or expansion strains on soot blower head and piping.

The Diamond floating mechanism reduces possible binding to a minimum, as it allows the soot blower to move parallel with the wall sufficiently to overcome any change in relative position of wall and bank of tubes.

The floating mechanism is also a direct means of support for the blower element, any movement being taken up by the spring "A" inside of the cylinder. The floating plate "C" serves as a seal to exclude air from the setting.

Elimination of binding of units is only one of eleven important advantages of Diamond Valv-in-Head soot blowers. Others include 50 per cent. saving in steam, 50 per cent. saving in labor, 60 per cent. saving in pipe and fittings, greater efficiency, etc.

Diamond Specialty Ltd., Windsor, Ont.

Diamond

VALV-IN-HEAD SOOT BLOWERS

Which Stoker?

-You Make this Decision Once-It Must be Right

The Canadian Stoker

JONES Stokers are made in Canada by Canadians and are paid for in Canadian money at par. The exclusive arrangement the extensive engineering resources of the Under-Feed Stoker Co., of America are made available for Canadian power users. This fine strictly Canadian stoker is backed by world-wide experience and unequalled engineering ability.

EXPERIMENT with any equipment is costly--but experiment with mechanical stokers is out of the question. The investment is large; it is made once in a lifetime; snap judgment won't do;--*Which stoker?*

Canadian plants want greater boiler capacity--continuous power day and night when necessary--they want this accompanied by greater economy in burning Canadian coals and by lower labor and maintenance costs.

This means *high-duty stoker firing*, best exemplified by the Jones "A-C" (Automatic-Cleaning) Stoker.

Regardless of the size of the plant, the grade of coal burned or the local conditions to be met, the logical, safe answer to *"which stoker?"* is Jones "A-C."

The new "A-C" catalog goes into detail. Jones engineers with unmatched experience in this specialized field, will gladly make a survey of your plant and give you the full benefit of the best they have learned in installing stokers in many prominent power houses. Investigation implies no obligation.

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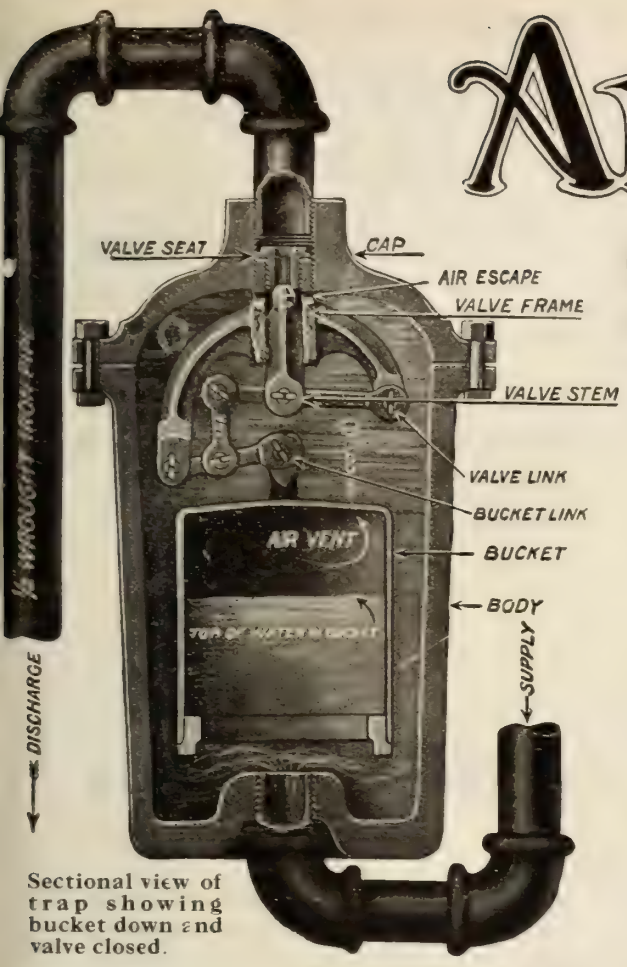
JONES "A-C" STOKERS



Sectional view of trap showing bucket down and valve closed.

Armstrong Steam Trap

Possesses Exclusive Features

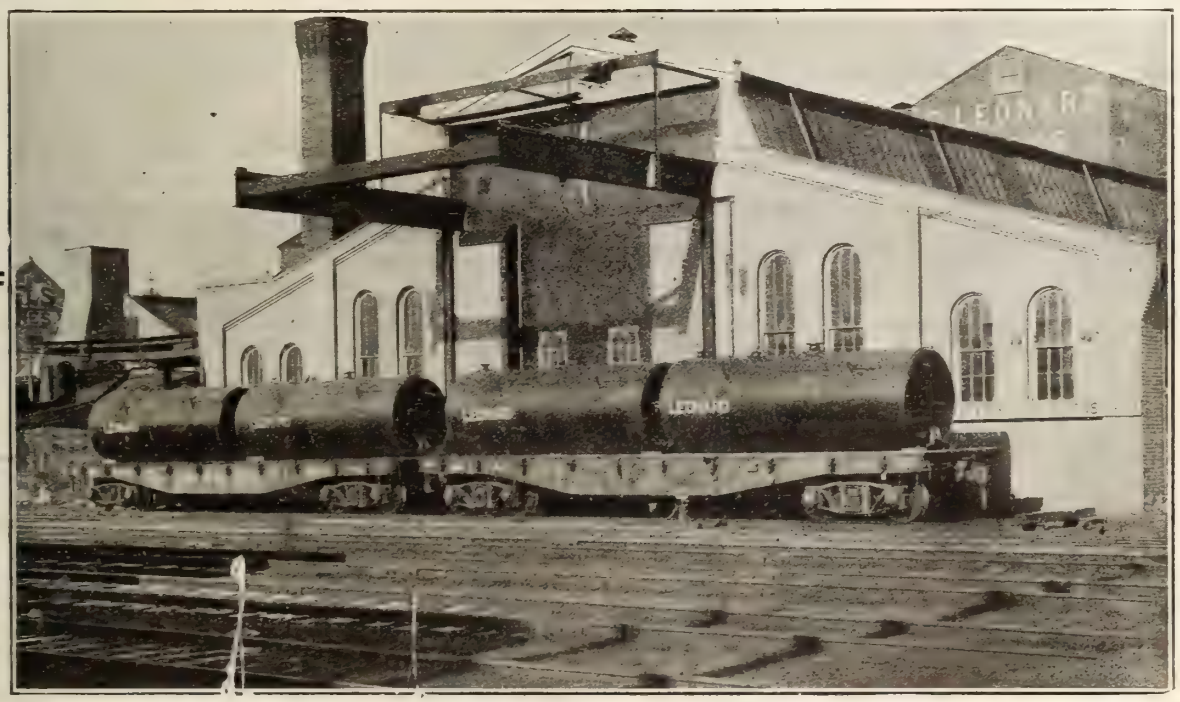
THE exclusive "Inverted Submerged Bucket" feature of the Armstrong Steam Trap makes it the best trap to handle your condensation.

The Armstrong Trap is small in size and light in weight compared with the ordinary trap. It is easily connected and may be suspended on a pipe line; neither foundations nor pits are required. This and the fact that an Armstrong is self-cleaning and operates with little attention, is the reason for its widespread popularity with big power plants.

Send for complete information.

The Arthur S. Leitch Co.,
LIMITED

1001-2 Kent Building, Toronto, Ont.



Shipment of Four 150-H.P. (72" x 18) Return Tubular Boilers for 150 lbs. working pressure.

Head Office and Works, London, Canada

E. LEONARD & SONS, Limited

Branches and Agents from Coast to Coast

Established 1834

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A HIGH TRIBUTE

to the efficiency of a

REES RoTURBo PUMP

at the Waterworks Pumping Station

SUDBURY, ONTARIO

THE TOWN OF SUDBURY, ONTARIO

February 11, 1922.

The Goldie & McCulloch Co. Limited,
Galt, Ontario.

RE: PERFORMANCE OF 6" REES RoTURBo PUMP

Dear Sirs:

I have your letter of the 4th, requesting information as to the performance of the new 6-inch REES RoTURBo Pump which you supplied for our Pumping Station, as compared with the old turbine pump which we have discarded.

The capacity and increased efficiency are as follows:

Capacity of Rees Pump per 1 KW. of power per hour: 533 gallons at 120 pounds pressure.

Capacity of old pump per 1 KW. of power per hour: 347 gallons at 120 pounds pressure.

Saving per KW per hour ..... 186 gallons
Saving per KW per day ..... 4464 gallons.
Saving per KW per year (300 days) .....1,339,200 gallons.

The above figures were obtained from readings of the Venturi Meter and the Graphic Recording Watt Meter.

I trust that this information may be of some interest to you, and beg to remain,

Yours very truly,
R. H. Martindale, Supt.

Sole Canadian Manufacturers

The Goldie & McCulloch Co.

Limited

Galt, - Ontario, - Canada

Toronto Office: Suite 1101-2 Bank of Hamilton Bld'g.
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REES RoTURBo PUMPS

are positively Self-Regulating

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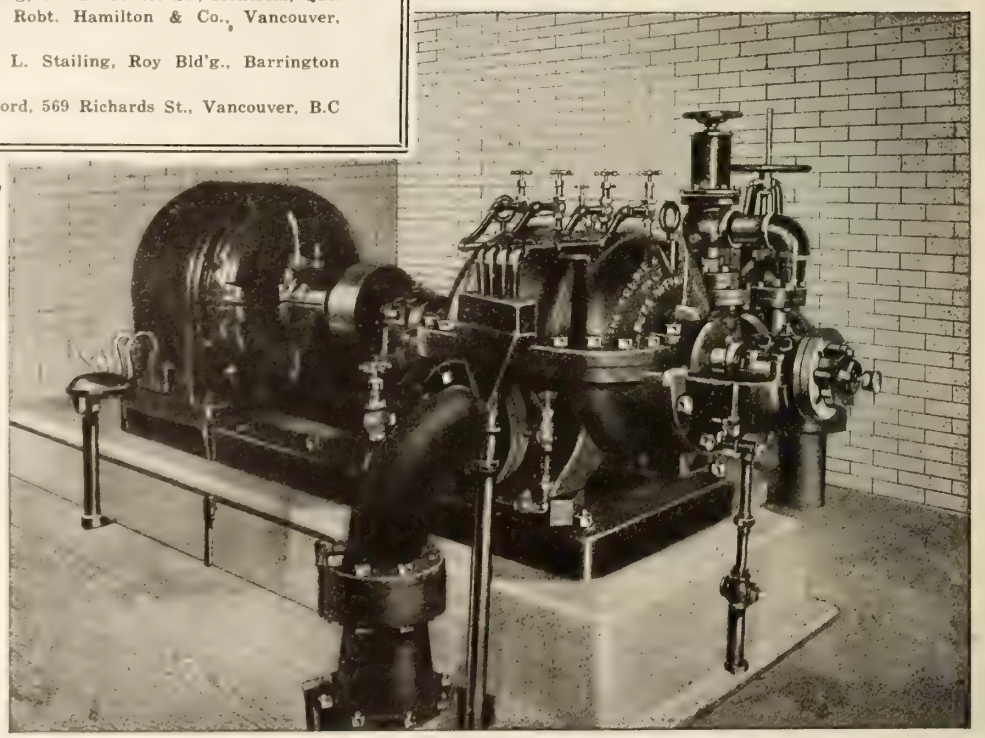

Illustration shows the Pump referred to in the above letter.

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POWER HOUSE

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The Power Plant Journal of Canada

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Refrigeration For the Power Plant Engineer

In This the Third Article, the General Principles of the Ammonia Compression System Are Taken Up—The Properties Which Make Ammonia a Good Refrigerating Medium Are Explained

By T. H. FENNER

THE AIR machine, which was described in its general features in the last article, is not in very wide use. The great objection to it is the large space occupied, but it is the advantage of employing a refrigerating medium that is available at all times and all places. This made it very suitable for marine work where vessels might be a long time absent from the home port, or from a place where they could get a supply of any other refrigerating medium. These other refrigerating mediums have not yet been mentioned, but we will now devote a little time to the consideration of what qualities are necessary in a liquid or gas in order to make it suitable for use in a refrigerating machine.

We have seen that in order to lower the temperature of a room by means of mechanical refrigeration that we have to do a certain amount of work. This is in accord with the law of physics which states that it is impossible for any cold body to transfer heat to a hotter body without external aid. In the air machine we have taken a certain amount of air, and by doing work on it, have raised it in temperature and pressure. The temperature is absorbed by the walls of the cylinder in which compression takes place and is carried away by the circulating water. We have thus rejected heat at a high temperature. The air is now allowed to expand and do work on a second piston, the work being obtained at the expense of the intrinsic energy of the air, and this is the temperature. As the temperature was about that of the atmosphere when expansion commenced, the temperature at the end of expansion will be very much lower than the atmosphere and the air is capable of taking up heat from the surrounding air if passed through pipes or even if blown direct into the room to be cooled.

Now the reason that air is a suitable refrigerating medium is because it closely resembles a perfect gas. That is its intrinsic energy, or its capability of doing work is entirely dependent on its temperature. Air has a specific heat of approximately .24, and therefore every 778 foot-pounds of work which is done on it, as in compression, will produce an increase of temperature of 4 degrees.

If this increase of temperature is carried off by the circulating water as fast as it appears, the energy in the gas after compression will be that due to its temperature, and this will be determined by the circulating water. These temperatures are measured from absolute zero. It follows then that when the air is expanded and does work against a piston that for every 778 foot pounds of work performed there will be a drop of 4 degrees.

A refrigerating medium to be usefully employed must have the property of absorbing large quantities of heat per unit mass or volume of the medium. It must also be able to absorb this heat at a low temperature level. It must also be capable of rejecting heat at a moderate temperature level.

There are a number of mediums which fulfill these requirements to a greater or less extent, but the two chiefly used for industrial purposes are anhydrous ammonia and carbonic acid gas. Other mediums are ethyl chloride, sulphur di-oxide, and a combination of the two latter. However for the purposes of these articles we may consider the two first mentioned as the most important.

Anhydrous Ammonia

We have seen that water, in order to be changed from its state of a liquid to that of gas, absorbs a considerable amount of heat, which is known as latent heat. At atmospheric pressure the boiling point is 212 degrees F. while the latent heat is 966 B. t. u. At pressure below the atmosphere the boiling point decreases, while the latent heat increases, the boiling point of water at an absolute pressure of one pound being 101 deg. while the latent heat is 1,034 B. t. u. Obviously, the temperature required to change water to steam even at almost a perfect vacuum is too high to enable it to be of any use as a cooling medium. It requires large quantities of heat to be absorbed, but at a high temperature level. Therefore a successful refrigerating agent must have a low boiling point, and having a low boiling point means that the change of state takes place at a low temperature level, under atmospheric pressure. It also means that the rejection of the latent heat at the same temperature level will reduce the vapor to a liquid again. Following this a little further, it also shows that a medium with a low boiling point at atmospheric pressure will have a still lower boiling point as the pressure decreases below the atmosphere. In order that this property of a low boiling point may be fully taken advantage of, the medium must possess in conjunction with it, a high latent heat. This is so that large quantities of heat may be absorbed at low temperatures approximating that of the atmosphere, and pressures within the limits of the materials which machines are made from. Anhydrous ammonia fills all these qualifications in great measure. It possesses a low boiling point, high latent heat, and can be liquefied at pressure well within the limits of ordinary practice.

Thus at atmospheric pressure anhydrous ammonia boils at a temperature of minus 28.5 degrees F. or 28.5 degrees below zero. Its latent heat at this temperature and pressure is 592 B. t. u.

At pressure of 141 lbs. absolute, or 126.3 by gauge, its boiling point is 75 degrees F. or reversing the process it will liquefy at 75 degrees F. and its latent heat at this temperature and pressure is 508 B. t. u. Therefore if ammonia absorbs heat at a pressure of 14.7 absolute, and it is raised to a pressure of 141.7 absolute, nearly all the heat due to this pressure can be rejected to the circulating water.

Carbon Dioxide CO_2

Carbon di-oxide gas, or CO_2 requries much higher pressure to enable it to perform the functions of absorbing and rejecting heat. Its pressure at zero Fah. is 308 lbs. per square inch, and its la-

tent heat 117 B. t. u. Its pressure at 70 deg. Fah. is 847 lbs. per square inch and its latent heat 63.33. The machines for handling this gas must therefore be of much greater strength, and the quantity of refrigerating fluid for a given cooling effect will be much greater. CO_2 machines were much used in marine work for the reason that the gas is inert, and heavier than air. If any escape due to a break or a bad leak, occurs, the gas falls to the lowest possible position, and there is far less danger of asphyxiation than with ammonia. The latter, being light and volatile, spreads all over, and is very dangerous to those in its vicinity.

In stationary practice, the greater majority of the machines are on the ammonia system.

The Ammonia Compression System

The principle of refrigerating having been shown to be a method of absorbing heat from the system to be cooled, and afterwards rejecting it at a higher temperature, we can examine the actual process in more detail.

If ammonia were plentiful and cheap as water for instance, we could utilize its low boiling point and high latent heat to refrigerate the rooms by simply circulating the ammonia through coils, and letting it run to waste after it had been vaporised. The temperature of the room could thus be lowered by the extraction of the necessary heat required to boil the liquid ammonia, that is 591 B.t. u. per lb. of ammonia. All the heat would not be available for cooling effect, for if the cylinders containing ammonia were situated outside the room to be cooled, they would be at atmospheric temperature, and before the liquid would start to vaporise, its temperature would have to be reduced to the temperature of the room. For instance if the ammonia was at a temperature of 70 degrees, and the cylinder were attached to the valve leading to the coils in the room to be cooled, which we will assume is at a temperature of 60 deg., then each pound of ammonia would give up 10 B. t. u. to the room before the vaporising effect commenced. Its actual cooling effect would then be 581 instead of 591 B. t. u. per lb. of ammonia. As the temperature of the room became reduced, the ammonia would give up more heat to the room and its cooling effect would be lessened.

If we had a room containing 1,000 lbs. of air at 60 degrees, the total heat units in the air would be 1,000 x 60 x .24, the latter figure being the specific heat of air. There would thus be 14,400 B. t. u. in the room. If ammonia at a temperature of 70 degrees was introduced into coils from a cylinder through an expansion valve, its pressure would drop to atmospheric pressure and it would be in a superheated state. It would give up heat to the air of the room until the temperatures were equalized, after which it would vaporize, and each pound would extract from its atmosphere 581 B. t. u. that is the difference between its latent heat and the amount of heat it had given up in dropping to the temperature of the surrounding atmosphere.

If the ammonia gas were going to be discharged into the atmosphere its pressure would have to be at least slightly above that of the atmosphere. Then the lowest temperature to which it could fall would be 28.5 below zero. If the room were to be reduced from 60 degrees to 32 degrees, then the air would have to give up 1000 x (60-32) x .24=4320 B. t. u. The average cooling effect of the ammonia would be 591-10 plus 591-38 divided by 2, or 562 B. t. u. per lb. Then it would require 7.6 lbs. of ammonia to obtain the effect required.

Ammonia, however, costs a considerable amount of money, and cannot be lightly discharged to the atmosphere, outside altogether of the effects on the neighbours. It is therefore necessary to have a machine which can continually recover the ammonia after it has done its work, and convert it again from a gas to a liquid, so that it is once more available to absorb latent heat.

This is where the compressor fulfills its function.

Suppose that instead of allowing the ammonia to be discharged to the atmosphere and lost, we attach the discharge end of the coils to a pump, which will draw the gas from the coils after it has done its work, and on the discharge stroke, discharge the gas into a chamber where it an be stored. If there is no outlet to this storage side, the addition of the gas to its contents will raise the pressure, so that there will be a distinct difference between the suction and discharge side. This means that the gas will have to be compressed from the volume it occupied at the suction pressure to the volume of the discharge pressure.

The work done by the pump in compressing the gas to the smaller volume will appear as heat in the gas, and as additions of temperature cause addition of pressure or volume as the case may be, this will still further increase the pressure. However, some of the heat of compression will be absorbed by the metal of the cylinder in which it is compressed, and if no provision is made to carry it away, these walls would speedily become too hot for working. It becomes necessary then to provide a means of of getting rid of this heat, and the method adopted is in some cases to provide the cylinder of the compressor with a jacket, and circulate cooling water through this jacket. Another method is to inject a small quantity of liquid ammonia into the cylinder with the gas to be compressed, and the heat of compression is utilised to evaporate this liquid. The increased temperature is thus carried away, leaving the gas in the discharge side of the compressor at the temperature corresponding to its pressure, or perhaps slightly superheated.

As the cooling water or other means cannot reduce the temperature of the gas leaving the discharge side of the pump much below 90 degrees, we find that the pressure due to this temperature is about 180 lb. absolute. It follows then that if the pump were to continue working and no outlet provided from the high pressure side the pressure would speedily become abnormal. However, this is not what is done.

The gas from the pump is discharged into a condenser, which takes various forms which will be discussed later. Here the gas is circulated through coils or around coils, in contact with water on the other side. This water carries away the latent heat, causing the ammonia gas to condense, and again become liquid.

This is quite analogous to the action of the condenser in steam practice. We have then a continuous discharge of gas from the pump, and a continuous liquefaction of the gas in the condenser. This liquid falls to the bottom of the condenser, or into another vessel known as the receiver. The outlet from this is by means of a valve which can be regulated to give as small or as large an opening as is required, and is known as the regulating valve, or expansion valve.

We have thus found two distinct sides to the system. A low pressure side, where the liquid is evaporated and takes up the heat required to effect its evaporation from the bodies surrounding it. This side of the system is at low temperature as well as low pressure, and is on the suction side of the compressor or pump. On the discharge side of the pump we have a region of high pressure, wherein the gas gives up the heat which it has absorbed in the low pressure side, and also the heat due to the work performed in compressing it, the result being that it is again liquefied.

Separating these two sides is a valve known as the regulating valve, through which the liquid is allowed to pass from

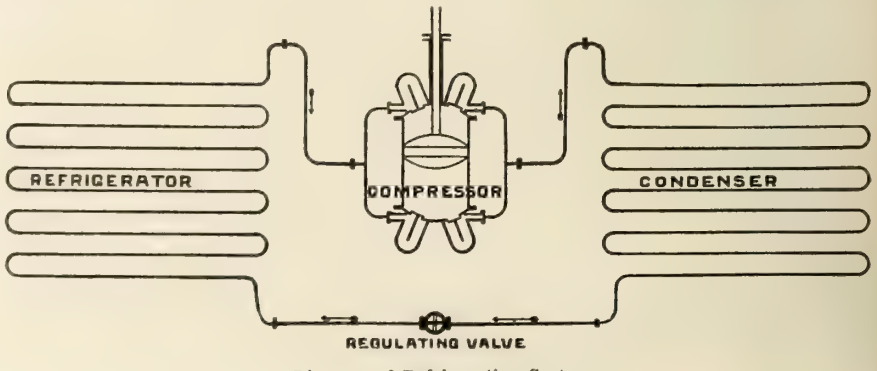


Diagram of Refrigerating System.

the high pressure side to the low pressure side, at a rate determined by the temperature to be maintained. When the liquid passes this regulating valve, its pressure is at once lowered to the pressure of the suction side. Its temperature is still that of the high pressure side, and it first gives up the difference in temperature between the liquid and the contents of the low pressure side. It is then a liquid at low pressure and temperature, and provided the heat is available to perform the function, it will vaporise. This heat is present in the air of the room to be cooled or the brine coils as the case may be, and the liquid absorbs this heat, flashing into a vapor as it does so. It is drawn away by the compressor, and is again put through the cycle of compression and liquefaction, and so on.

It is therefore obvious that if there were no leaks on the system the same charge of ammonia could be used indefinitely. This is pretty nearly so in practice, but due to the leakage at glands, etc. it is necessary from time to time to make additions to the quantity of ammonia in the system to make up for unavoidable losses.

Cooling Effects

From the foregoing we can see that for a definite amount of ammonia circulated at a certain pressure and temperature on each side of the regulating valve, a definite cooling effect is available.

Supposing we have a refrigerating machine, in which the ammonia is coming from the cold room at a pressure of 294.4 lbs. absolute, and is going to the condenser at a pressure of 139.7 lbs. absolute. The temperature corresponding to the suction pressure is approximately zero, and we can assume that the temperature of the brine of the room to be cooled is 10 degrees above that or 10 degrees F. The temperature corresponding to the pressure on the discharge side is 75 degrees, and the latent heat of ammonia at the suction pressure is 572.2 B. t. u. In passing the regulating valve the ammonia liquid will give up to contents of the suction side 75-10 or 65 B. t. u. per lb. This leaves available 507 B. t.u. per lb. for cooling effect. If we are developing 10 tons of refrigeration per 24 hours on the machine, this means that we have 2,800,000 B. t. u. per 24 hours or 120,000 B. t. u. per hour to absorb. Each pound of ammonia is capable of absorbing 507 B. t. u. so that we must circulate 2,366 lbs. ammonia per hour. The volume of ammonia gas at a pressure of 29.4 absolute is 9.19 cubic feet per lb. so that the compressor must be capable of dealing with 2,171 cubic feet per hour, or approximately 36 cubic feet per minute. If the compressor is double acting the cylinder must have a capacity at 120 strokes per minute, of .3 cubic, which gives a diameter of about 7½ inches with a twelve inch stroke.

This of course is only an approximation, but it shows the relation between the amount of ammonia circulated and the refrigerating effect.

It will be noted also that the closer the pressure of the condenser that the dicharge side is to that of the suction side, the less work will have to be done by the machine.

The expression for the efficiency of a steam engine is

$$\frac{\text{Heat Put In—Heat Rejected}}{\text{Heat Put In}} = \text{Efficiency}$$

If we take a steam engine working at 100 lbs. initial pressure, and exhausting at atmosphere pressure, the efficiency will be found from the absolute temperatures at initial and exhaust pressures. This is of course the theoretical efficiency. We have then

$$\frac{T—T1}{T} = E$$

and T is 337 plus 460 while T1 is 212 plus 460. Then we have

$$\frac{152}{797} = .19 \text{ or } 19 \text{ per cent. efficiency.}$$

It is obvious that the greater the difference between the initial and final temperatures, the greater will be the efficiency of the engine.

As the refrigerating machine is a heat engine reversed, it is also obvious that the closer the temperatures and therefore the pressure of the suction and discharge side approach each other, the more efficient will be the machine. Of course there are practical limits to this, but they are well defined. Efficiency is of course the proportion of the amount of work necessary to drive the machine to the cooling effect obtained.

Details of the System

The foregoing is the general description of the ammonia compression machine, and may be taken as that of the CO_2 machine. The details of the machine differ with different builders, but the various parts are of the same general design.

There are two general systems employed in refrigerating, whether the machine use is of the absorption or compression type. We have not yet dealt with the absorption type of machine, but will do so later.

The two general systems are known as the direct expansion or the brine system. In the direct expansion system the ammonia liquid is expanded through the regulating valve into coils which are placed directly in the room to be cooled and the refrigerating is effected directly by these coils. In the brine system the ammonia coils are placed in a tank, in which is a solution of water and calcium chloride, which has a sufficient density to prevent its freezing at all ordinary temperatures. The ammonia extracts the heat from the brine which is circulated through the rooms to be cooled and takes up the heat from there. This heat is again given up to the ammonia the brine being cooled off and returning to the room to absorb more heat. There is thus a refrigerating medium, the ammonia, and a cooling medium, the brine, instead of only just the refrigerating medium as in the direct expansion system.

These two systems have different advantages, according to circumstances, and are both largely used.

In the next article we will describe some of the details of the compression system, before taking up the absorption method of refrigerating.

POWER EXHIBITION

Announcement has been made of the National Exposition of Power and Mechanical Engineering to be held at the Grand Central Palace, New York, from December 7 to 13, inclusive, (except Sunday intervening) by the managers of the Exposition.

The Exposition was decided upon by a group of engineers and manufacturers who had felt the need for such a means of having men get together, exchange ideas, see the latest development in equipment and lay problems before the manufacturer.

The business opportunity where a manufacturer may meet a large assemblage of power plant and mechanical engineers and capitalists interested in power, is significant to firms keen for such business. A number of progressive manufacturers have already engaged space for their exhibits.

The Exposition will immediately follow the annual meeting of the American Society of Mechanical Engineers and it is expected that the exhibits will supplement the programs and discussions at the professional meetings of the Society. The Professional Divisions of the Society will hold sessions relating to fuels, stokers, steam power plants, railroads, steam utilization in the paper industry, textile and gas power, and it is expected that the exhibits at the Exposition will throw interesting light on the papers presented at these sessions of the A. S. M. E. meeting.

That the Exposition will be comprehensive may be inferred from the plans which are to include exhibits of every type of machine, apparatus, equipment, instrument, device and the various materials and supplies necessary in the operation of the complete power plant. The committee decided that its keynote should be " an Exposition of apparatus employed in the generation, distribution and utilization of power."

The Advisory Committee for the Exposition under the chairmanship of I. E. Moultrop of the Edison Electric Illuminating Company of Boston, is comprised of : Milan R. Bump, President National Electric Light Association; N. A. Carle, V. P. and Gen. Mgr. Public Service Production Company; A. G. Christie, Prof. Mechanical Engineering, Johns-Hopkins University; Fred Felderman, National V. Prest., National Association of Stationary Engineers; E. B. Katte, Chief Engineer, Motive Power, N. Y. C. R. R.; Dexter S. Kimball, Prest., The American Society of Mechanical Engineers; Fred R. Low, Editor "Power;" David Moffat Myers,

(Continued on page 24)

Some Notes on Gas and Oil Turbines

While There Have Been Many Experimental Internal Combustion Turbines, There Are None in Commercial Use. Some of the Reasons Are Shown by the Author of This Paper

By MAX SCHUELE

Read Before The German Union of Electro Technicians.

THE problem of the gas and oil turbine has busied a great number of engineers during the past twenty years. In spite of these researchers and their many inventions, we fail to find a gas turbine in commercial service. In Germany, the Holzwarth turbine, built by Thyssen & Co., is undergoing a series of severe tests. In other countries nothing has been done save the French experiments with the Armengand-Lemale turbine, which work has been discontinued.

The Holzwarth gas turbine is supposed to follow the fundamental working principles of the Otto gas engine, in which heat is added at constant volume and after performing work the remainder is rejected at constant volume. In fact, the cycles are not identical, since precooling of the gases of combustion has been found to be necessary in the turbine. This precooling is absent in the reciprocating gas engine, although there is an unavoidable cooling during combustion by the jacket cooling water.

Engineers will recognize the thermal disadvantage that lies in this precooling, for if the heat or part of the heat of combustion is allowed to escape, instead of a working process we have merely a heating and cooling cycle. The precooling of the burning gases, in the gas turbine, which are at temperature of 2,800 to 3,500 deg. F., is in sharp opposition to the principles which have, in the gas engine, proved to be fundamentally sound and may be looked upon as the main reason for the failure of so many experimental turbines.

In the constant-pressure gas turbine combustion is carried out continuously and the gases pass out of the nozzle onto the blades at a uniformly high pressure.

The blade surfaces of this type of turbine attain the temperature of the uninterrupted stream of hot gas flowing through the machine. This temperature cannot be held higher than 800 to 900 deg. F. if burning of the blades is to be avoided. As it is impossible to reduce the temperature from that of combustion, say 3,200 deg. F. to 900 deg. adiabatically at the available pressure drop in the nozzles of 150 to 300 lb., the gases must be cooled before entering the turbine. This result is a thermal loss, and an economic loss as well, by reason of the reduced output per machine. The cooling is required not alone to protect the combustion space, where a gas temperature of 3,500 deg. F. is constant. This has been the stumbling block in gas turbine progress up to the present time.

To avoid this precooling loss, the gas and air mixture in the Holzwarth turbine is distributed to from six to ten combustion chambers. The first rise in pressure after combustion starts, closes the inlet valve and opens the burner valve. The gases pass through this valve into the turbine, the potential energy being transformed to kinetic energy at the nozzle, the entire events taking less than one-tenth of a second. This process is repeated by each chamber in rapid succession. Each combustion chamber has a charging as well as a firing period, and as in the gas engine, the cooling jacket combustion chamber absorbs less than 10 per cent. of the developed heat.

It is possible to operate the wheels with a gas temperature of 1,800 deg. F. if the contact lasts only a short time and is allowed by contact with cold air. As for blading, soft electro-iron is used, and this metal appears to stand up satisfactorily, the blades being threaded and screwed into the wheel rim.

The action of the gases in the Holzwarth gas turbine is by no means similar to the action of steam in a steam turbine. The steam issues in a steady stream, while the gas issues from the nozzles of the gas turbine as a succession of impacts, sounding much like machine-gun fire. The bucket wear in the gas turbine is correspondingly increased.

In the Holzwarth machine wheels with pressure stages are not used. The steam turbine has a pressure drop from, say, 13 atmos. to a final pressure of 0.05 atmos., or a ratio of 260, and it would seem that, since the gas turbine has a step-down ratio of from 10 to 20 by 1, a wheel with a single-pressure stage should be ample to give this pressure ratio. One need only consider whether a wheel with several rows of velocity buckets or with but one row is to be used.

Everything said so far for the gas turbine applies to the oil turbine, as the machine is but slightly modified and a fuel valve added.

During the end of December, 1920, an oil turbine, was built by Thyssen, according to plans of Mr. Holzwarth, and put into actual running. The six combustion chambers, each having a volume of 5.18 cu. ft., are arranged around the shaft. The oil centrally injected into oblong combustion chambers by an air-pressure atomizer after the chambers have been filled with fresh compressed air. The oil cloud thus produced fills the chamber completely and is ignited by several high tension spark plugs not shown. The first experiments showed that in this manner heavy oil may be burned without residue and the combustion and resulting pressure are the same as when gas fuel is used. The temperature must be kept high enough to insure ignition, and oil cloud must not come into contact with any cold walls. It is not impossible that benzol-carbon hydrates may be burned without residue. During the experiments it was found that a simultaneous performance of the six chambers could be kept up with a normal rotation of the shaft of 2,700 per minute. Regular running and performance experiments are to follow. Up to now the following facts have been brought out: A medium temperature in the combustion chambers of from 875 to 1,000 deg. is secured, while in the wheel chamber, and at exhaust the temperature is from 800 to 875 deg. In a cast-steel combustion chamber 9 per cent. combustion heat was taken up by the cooling water, while the duration exhaust was found to be less than 0.1 second.

Even if good performance of the experimental gas turbine has been proved, there still remains the difficulty of conveying the greatest possible part of this performance of the shaft. Future experiments will be in the direction of obtaining effective results and improving the form of valves, buckets, the form of the wheel chamber, the time of contact and the air-cleaning system. According to the latest stage of the experiments undertaken in 1921 and the extension of the same, there is a well-founded opinion that the Holzwarth turbine will reach the same grade of development as has the steam turbine. In addition the net thermal efficiency should reach a minimum of 30 per cent. in contrast with the 20 to 22 per cent. obtained by the modern steam turbine.

An examination of the work done in Germany on the gas turbine leads one to feel that there is no basic reason why this form of prime mover should not be made commercially successful. The difficulties yet to be overcome are not greater than those that confronted the early steam-turbine designers. Since the cost of the steam turbine is but a fraction of the total cost of the steam-plant equipment, the gas turbine, when developed into a commercial proposition, should more than compete with other forms of engines. While a low-pressure steam turbine is a necessary appendage, if the greatest efficiency is to be obtained from the gas turbine, it is feasible to far exceed the efficiency of the present-day steam plant even though the gas-turbine exhaust heat be thrown away.

C. A. S. E. Competition Questions

PAPER NO. 6.

Question:—What is a steam trap? Describe at least three well known makes and their operation.

Answer:—A steam trap is a device for automatically removing condensation from a steam line or any other place where it is objectionable without permitting the escape of steam.

Well known makes are (a) the Anderson, containing about the same number of parts as a watch. This is a continuous flow trap with a float operated valve.

(b) The Wright, also a continuous flow trap with float operated valves.

(c) The Strong, a bucket trap, with intermittent discharge.

Question:—Engineers usually have a preference for a certain type of trap. Give three reasons why different types are preferred. The soundness of the reasoning is what will count.

Answer:—Some engineers prefer a continuous flow trap for the reason that as the flow is continuous there can be no shock or water hammer in the discharge line. If the trap is equipped with a water gauge and the float is properly adjusted it can be easily seen whether the trap is operating and it may possibly be known whether it is discharging steam.

Others prefer a bucket trap with intermittent discharge because they claim that as the operation of the trap is audible it can be known by listening whether the trap is operating, also because the valve is either open wide or shut tight, wire drawing is eliminated and thereby cutting of the valve is reduced and the maintenance expense reduced.

Still others prefer a thermostatic trap which permits adjustment so that the temperature of the condensate discharged may be reduced to or below 212 deg. thus getting more work from the heat in the steam. The two first mentioned types discharge water no matter what its temperature may be and the temperature will depend on the pressure.

The two first mentioned types to which may be added the tilting type of trap are the only ones that should be used to protect engines while the thermostatic may be used to drain water heaters, radiators and similar service.

Question:—Describe the operation of a soot blower for return tubular and water tube boilers. Give reasons for their installation proving same by possible savings in dollars and cents.

Answer:—A soot blower is a mechanical device for directing jets of steam so as to remove soot from the heating surface of a boiler. In the case of a return tubular boiler it consists of a movable member located in the combination chamber or in the smoke box connected with an externally located valve by means of which the steam may be admitted. A wheel is provided by means of which the movable member may be rotated.

In the case of a boiler of the B and W type the movable members are placed in the different passes above the tubes.

Soot is a very high grade heat insulator and is very much favored by the coal man for obvious reasons. One quarter of an inch of soot has been found by experiment to account for 38 per cent. of the fuel and ⅛ in. is considered to equal ½ in. of asbestos.

If the thickness therefore could be maintained at ¼ in. and a boiler uses 6 tons of coal at $10.00 per ton per day for 300 days in the year the value of the coal burned would be 6 x 10 x 300 = $18,000. The value of the coal wasted would be 38-100 x 18,000 = $6,840.

This is quite a few dollars but no cents.

Question:—Describe the operation of a safety valve and cite experiences of failure with reasons for failure.

Answer:—A safety valve, of which there are three types, namely the spring loaded, the weight and lever, and the dead weight, is a device for automatically opening at a predetermined pressure to permit the escape of steam from a boiler.

Failure to operate may be due to a desire on the part of the engineer or fireman to avoid waste of steam in which case the valve may be braced in some way so that it can't operate. Or failure may be due to what is called corrosion but which is more likely a collection of matter about the valve which binds it to its seat. (The seat and disc are supposed to be made of non-corrosive metal.)

Question:—Why is the hydrostatic test preferred by boiler inspectors in preference to any other?

Answer:—Preference is due to the incompressibility of water.

Question:—Give some reasons for a reduction of allowable boiler pressure and the methods of guarding against the faults named.

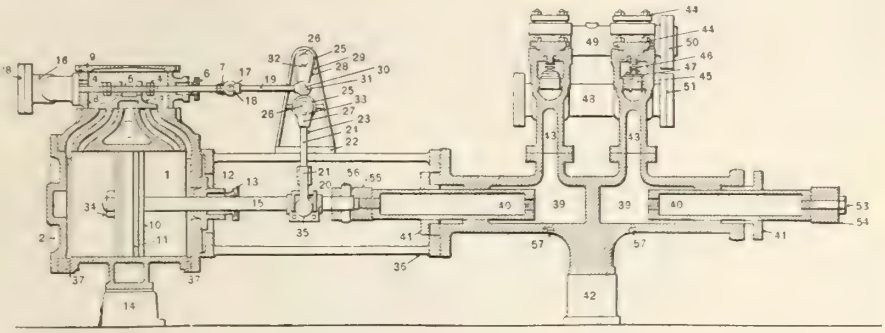
Answer:—Internal pitting and corrosion due to certain qualities in the water. Correction of the water by means of chemicals will prevent this.

External corrosion due to leaks. The remedy for this is the prevention of leaks.

Growing of the shell by faulty caulking.

A hand hole in the rear of the boiler permitting leaking. Hand hole is not allowed now.

A duplex pump consists of two pumps

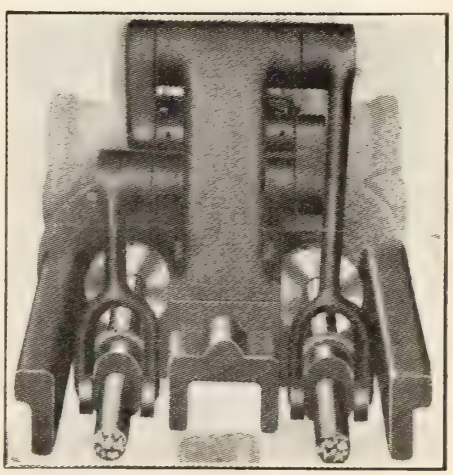


Duplex Pump.

side by side. One side we may call the right hand side and the other the left hand side.

The valve on the right hand side is operated by the left hand pump and the left hand pump valve by the right hand pump. Both valves are direct, the valve moves in the direction the piston is to move or outside edge of valve is the steam edge. One of the rockers however is indirect and the other direct. The valves have no lap either steam or exhaust.

To set the valves the pistons are placed in mid cylinder and the rockers



Valve Driving Mechanism.

set vertical and fixed securely to the piston rods. The length of the valve rods is then adjusted so the valves can be moved an equal distance on each side of the middle of the ports.

Question:— Describe a centrifugal pump and cite some of the reasons given for its adoption. Criticize the reasons given.

Answer:—A centrifugal pump consists of a shaft equipped with radial

vanes revolving in a casing. The water enters at the center of the casing, is caught by the vanes and thrown by centrifugal force to the outside of the casing in which the outlet is located. It occupies very little space which is true. It uses very little oil which is also true. It delivers the water without shock which is true again. No packing of plungers, another truth. Altogether it looks like a good proposition.

Question:—Describe an injector and state fully its action.

Answer:—An injector is a device for feeding water into a boiler by making use of the velocity of steam flowing through an orifice or nozzle to impart velocity to water and thereby enable it to move against a head or resistance.

Question:—Describe a non-return valve and state why in your opinion these should be made standard equipment in all boiler plants?

Answer:—A non-return valve is so designed that it will permit flow in one direction only. It resembles a globe valve in appearance with the spindle detached from the disc, the disc being equipped with a spindle on the lower side working in a guide and on its upper side with a piston working in a cylinder or dash pot to prevent chattering. By means of the screw spindle the valve may be forced to the seat and held there.

The valve is installed in the steam outlet from the boiler in such a way that steam may flow out of the boiler but not into it.

Engineers, firemen and insurance companies are the only ones interested in the adoption of such safety devices for obvious reasons but if engine and boiler room were required by law to be installed directly underneath the head office they might be more interested in their adoption.

Coal Power vs. Water Power For Cities

The Adoption of Hydro Electric Power is Not Always a Distinct Saving, as is Shown Very Clearly in This Article, for Which We Are Indebted to "Steam Power"

By E. E. DILLON

SO MUCH has recently been said and written about the wonderful possibilities and economies of water power that there has been a decided and in most cases an unjustifiable tendency to slight the value of steam power for public utility.

To understand the comparative merits of steam and water power it is necessary to go beneath the surface fact that water power entails no fuel cost and get down to the actual figures and costs affecting communities using steam power and water power respectively.

As distributed at present, water power is in a great many cases costing as much as the same amount of power would cost if produced by coal burned in furnaces properly constructed; and in practically all cases, if the steam plants for which this water power has been substituted had utilized the exhaust steam from engines for heating buildings commercially, the revenue of the steam plant could have been enormously increased and the resulting economy passed on to the public by dispensing with the wasteful operation of a great many private furnaces for heating buildings.

The idea has been disseminated that electricity produced by water power can likewise be commercially used for heating buildings; but that this is true only to a very limited extent is brought out very distinctly by comparing the cost and heat equivalent of electricity with that of coal.

The fundamental unit of power is the horsepower, which is 33,000 foot pounds of work per minute; and its heat equivalent is 42.4 B. t. u.'s per minute or 2,545 B. t. u.'s per hour. Now if a kilowatt hour costs 5.5 cents, which is at the rate of about 4 cents per hp. hour, then 4 cents would be the cost of 2,545 heat units in electrical energy, or about 16 cents for 10,000 heat units, which is the heat value of one pound of bituminous coal that sells in the State of Wisconsin and the middle west for $6.00 per ton in carload lots.

From this it is seen that one pound of this coal will cost three-tenths of one cent, which is the cost of 10,000 heat units of coal energy. But about 75 per cent. is the efficiency obtained when the coal is burned in the best modern power plant furnace, so that 10,000 heat units of energy from the coal actually costs about four-tenths of one cent, as against sixteen cents for 10,000 heat units of electrical energy.

The cost per horsepower for developing a hydro-electric power plant, including transmission lines to market the power, is about the same as for a steam plant, including central heating pipe system, to market the exhaust steam for heating buildings commercially. And the principal advantage of such a steam plant over the water power plant is that it can furnish electric light, power and steam heat for commercial heating of buildings from the same coal; or it can furnish either one of them independently, whereas the water power plant can furnish only the electric power, and at the same time coal must be bought to heat the buildings of the business portion of the city or village, which is in addition to the cost of electrical power.

There is still another very important advantage of the steam plant: When equipped with the best boiler plant equipment, it obtains, as stated before, an average efficiency from coal of 75 per cent.; whereas, the average efficiency of the best house-heating furnace is from 25 to 28 per cent. throughout an entire heating season. Therefore, it is seen that when a power line is extended into a city or village for the purpose of furnishing power and heat, thereby causing the local steam plant to be put ou tof commission, there is a loss to the municipality of the cost of all of the coal that is required to heat the buildings in the business portion of the city or village, for the simple reason that the amount of money paid to the outside power company for electric power will be sufficient to buy all the coal required to furnish all the electric power for the entire city or village and likewise the steam heat required to heat buildings in the business portion of the municipality.

It is evident in either case that coal must be bought to furnish heat for a city or village. So why not adopt the method that will require the least possible amount of it, thereby conserving both money for the municipality and coal for the entire country? Within the past five years there have been no less than twenty cities and villages with populations from 1,200 to 10,000 in the State of Wisconsin alone, that have made contracts of from five to ten years with large water power corporations for power, and have thereby discontinued the use of their steam power plants, which are now lying idle, rapidly depreciating. The average loss to these municipalities, as a result of the contracts thus made, has been over $25,000,00 per year. These statements are facts that can be verified by the records of the utilities in the cities and villages where the contracts were made with the water power companies for power!

POWER EXHIBITION

(Continued from page 21)

of Griggs and Myers, Consulting Engineers; Calvin W. Rice, Secy. The American Society of Mechanical Engineers; and the managers are Charles F. Roth and Fred W. Payne with offices in Grand Central Palace, New York, to which all requests for fuller information and reservation of space should be made.

Present Day Boiler Room Operation

In This Paper, Presented Before the Metropolitan Section of the American Society of Mechanical Engineers, the Authors Point Out Some of the Features of Boiler Operation

I. E. MOULTROP and R. E. DILLON

THERE is to-day no part of a steam generating power plant where scientific methods can be better employed than in the boiler room. Within recent years extraordinary advances have been made in the design of more efficient apparatus. Various meters and measuring devices have been developed and furthermore analytic methods have come into use for regulation and control.

Modern Advance

We can all point to equipment in operation to-day which bears a very unfavorable comparison with modern built apparatus in the matter of efficiency. I have in mind an electric light plant built in the year 1899. Its capacity was 10,400 kw. in engine driven units. The largest of these engines was 1,600 kw. and this required an oiler and two firemen in attendance. A modern station of the type such as has been erected in various parts of the country within the past three of four years is operated with one oiler and one fireman for each unit of 30,000 kw. or larger. The output per man is, therefore, twenty times as much in the modern station as in the older one.

Furthermore, 2.55 lbs. of coal, or 37,000 B. t. u. are required in the old engine driven plant to manufacture one kilowatt hour. In the modern station this is accomplished with 1.25 lbs. of coal or 18,000 B. t. u. which is almost one-half the former rate.

These figures are representative of the difference between the modern plant and many older plants which are operating to-day. Not all of the increase in efficiency can be attributed to the boiler plant, but a considerable part of it can.

The new larger boilers equipped with modern fuel burning furnaces which are going into so many plants to-day have an efficiency of 80 to 85 per cent. at the operating point of loading, which is a gain in efficiency of 15 to 20 per cent. over types installed ten years ago. The modern furnace and boiler is capable of being forced over peaks to a very much greater extent than the older installations and for this reason where the character of the load curve permits it, a great saving can be made over the practice of carrying banked boilers.

Another factor that is worth noting is the improvement that has been made in increasing the maximum load that can be supplied by a plant with a given number of boilers installed. Contributing to this is the improvement in the efficiency of the Prime Mover and the efficiency of the boiler room apparatus and also the improvement in the method of operating both boiler room and turbine engine. I have some figures in mind of a plant where growth has been normal and where modern extensions have been made which may be indicative of the average large power station. At this plant in 1905 the ratio of maximum load to capacity of boilers was 1 kw. per boiler horse power installed. To-day the rate is 8 kw. per boiler horse power installed.

Efficiency—Extensions

Accepting all these improvements and advances made we can now turn our attention to a discussion of the method of getting the best results from the plant.

If capital has been spent with generous provision for capacity there will be nothing to prevent operating at as low ratings and therefore as high efficiency as is consistent with operating considerations. However, as the load grows it becomes necessary to consider the installation of additional boilers and at this point (provided the present plant can carry the load by forcing) it must be shown that the new installation will permit the plant to be operated more efficiently. To interest capital it must be demonstrated that the improvement in efficiency in the plant due to the additional installation will be sufficient to pay the carrying charges, interest, depreciation and obsolescence, then show a profit or the new construction will not be undertaken. The point where capital charges across the gain due to increased efficiency in the plant determines the extent to which the additional installation can be expected to be carried.

Efficiency—Equipment

Every plant has characteristics which are peculiar to that particular place and these characteristics determine the maximum efficiency which can be obtained and upon which the operating plan must be based. The type of the boilers and fuel burning equipment and other apparatus is pointed out as one factor in the operating plan. If the type of equipment installed permits of a high enough rate of forcing to carry the peaks in the load which are of short duration, banking for these peaks will become necessary.

Efficiency—Load Curve

The character of the daily load curve has an important bearing on operation. Obviously if the load curve is flat and without peaks it will pay to operate the boilers at as near the point of maximum efficiency as is consistent with good operation and labor conditions and as the capacity of the plant will permit. If there are peaks in the load curve, however, the degree of forcing to employ over these peaks and the amount of banking to provide for them will depend on various considerations as will be shown later.

With modern equipment no appreciable gain in labor can be made by operating at higher rating since one fireman can take care of a row of several boilers and the lighting of additional boilers will not decrease the labor appreciably. However, some types of older equipment of small capacity require one fireman for a small number of boilers and the increase of labor with additional boilers is an important item.

The Daily Peak

The question now comes to a consideration of the peak load and whether to force the boilers over the peak or bank additional boilers for it. The duration of the peak enters into this question and the type of the equipment determines how long a given high rate of forcing can be maintained without difficulty in keeping the fires in condition. Considerably higher rates can be employed for short periods than would be practical for longer periods. Furthermore, the extent of high forcing and the period used affects the maintenance costs which mount rapidly with high rates and the time so used.

There is a point at which the loss due to extra fuel burned by forcing at a high rate over a peak is equivalent to the loss due to the alternate case of carrying additional boilers for this peak. I have selected an example to illustrate the importance of finding this point.

Suppose that 150 per cent. rating has been demonstrated to be the most efficient and practical for operation through the day. By forcing all boilers over the peak to a higher than 150 per cent. the plant may be run with less boilers banked while operating on the day and night loads, saving banking losses.

Having determined the number of boilers that should be installed, the number to have lighted and the number to have steaming at any time, the way is prepared to discuss the proper equipment necessary to produce the best results and the method of operation to accomplish this.

Method of Operation

Up to this point we have discussed methods of securing the highest efficiency by using the proper number of boilers and have dealt with a survey of modern equipment. A few words might be of interest now showing what steps the boiler room force takes to meet the changing loads and maintain efficiency.

The boiler room foreman is responsible for having a sufficient number of boilers lighted to take care of the daily peak and the proper number steaming to give best efficiency at all times determined as previously described. He authorises the number of boilers to be brought into

steaming or to be taken out to take care of the load which is indicated on a load sign located in the room.

Here the fireman's duty begins. With the knowledge of the load to be carried and the number of boilers to have steaming to carry this load, he refers to a curve which indicates how much coal he must burn in each furnace to produce the necessary steam. He looks at the tachometers which are scaled in pounds of coal being fed and adjusts the coal feed by means of the rheostat on the stoker's motors until the tachometers indicate the proper amount for output. The tachometers are provided with secondary scales which indicate the approximate air pressure to be maintained in order to supply the right amount of excess to burn coal.

He next adjusts the damper or if induced draft fans are in service, he regulates this to bring the draft over the fire as indicated by draft gauges for this purpose to a slight vacuum, usually about one-tenth inch. Pressure instead of draft would be better over the fire for reasons of efficiency, since it would overcome any tendency toward infiltration, but on account of the danger of blowing out through the doors when they are opened, and also as an aid in maintaining the furnace walls a slight vacuum proves better.

The fireman next looks at the steam flow meter to see if the proper amount of steam is produced and if this proves to be the case he looks at the steam gauge to see if the pressure is maintained.

If the steam flow or pressure indications are unsatisfactory he takes steps to correct this, keeping in mind the adage—"Service first—efficiency second."

After the steam flow and pressure are made satisfactory he turns his attention to the CO_2 recorder or air flow indicator to make sure that the right amount of excess air is being used.

In striving after high efficiency in the boiler room, due consideration must be given to co-ordination with other parts of plant. The efficiency figures in this part of the plant alone should not serve as a criterion for judging the good work of the fireman and the design of the plant. It is the efficiency of the boiler room and turbine room in conjunction which tells the final story, for if 2 or 3 per cent. can be sacrificed in the boiler room in order to gain 4 or 5 per cent. in the turbine room, the result will be justified.

Too often it is thought that the measure of efficiency is the loss to the ash pit and up the stack. This will not prove to be the case until the loss is weighted against the loss of heat to the circulating water in the condenser. Feed water can be heated throughout the great part of the temperature range from either of these two sources of heat. However, by utilizing some of the heat that would likewise go to waste in the circulating water, the turbine room gets the credit rather than the boiler room and provided this credit out-balances the loss in the boiler room, the case is justified.

Rapid Change in Load

The subject of boiler room operation is not complete without a word about the method of handling sudden changes of load with attendant effect upon the efficiency. During the day time, if there is a sudden increase of load, the boilers (if they are handled by the methods which have been discussed) are in a positon to pick it up quickly and can be forced for short periods to high rates without regard to economy. If there are banked boilers, as in winter time, these can be brought in if necessary.

The rapid change in conditions at seven o'clock in the morning on the average lighting company system is a problem which often proves difficult to handle.

If the lighting company is not tied in with other plants only the ordinary increase of the morning load has to be absorbed and the case is simple.

However, if the company is tied in with a water power inter-connection, the problem becomes hard to meet.

In seasons when there is sufficient water, the hydro-electric plants are apt to carry most of the combined load during the night time, and when seven o'clock in the morning arrives, the steam plant is required to pick up that portion of its load which the water plant has been carrying in addition to its own natural increase and cases might arise where this would mean that practically the entire load of the system would have to be absorbed by the boilers at this time.

Taking on the load under these conditions is a very inefficient proposition and an agreement should be reached which would strike a balance between the loss to the hydro-electric due to giving up the load gradually before the system load begins to increase and the loss to the steam plant due to the requirements for absorbing the increased load rapidly.

Emergency Condition

Schedule peaks and peaks that occu regularly are taken care of by forcing steaming boilers or by holding boilers in bank. Frequently, however, an emergency peak is thrown on the system sometimes with warning enough for a few minutes' preparation to meet it and sometimes with no warning whatever.

Thunderstorms

Thunderstorms can usually be discounted 10 or 20 minutes ahead and hot banks prepared, and fire and air pressure built up in the steaming boilers. In cases like this there need be no disturbance in absorbing the load and it can be done with slight decrease in efficiency.

Loss of Load

Another example illustrates a sudden decrease occurring on a lighting system when the tie line to an interconnection system opened bringing out three other lines with it and a total drop-in load of 23,000 kw. resulted. The excess steam discharged through the safety valve. Since it was necessary to reduce the air flow through the fires temporarily, the grates and settings were subject to damaging conditions and the chimneys belched forth black smoke.

In the final consideration of the economy of any plant—that is the ratio of B. t. u. to power produced, due consideration must be given to all factors which affect it, that is, to the apparatus that performs the work and the daily conditions which tend to increase or decrease the economy.

Light Space and Cleanliness

The story of the present-day boiler room operation would not be complete without a word about conditions in the boiler room under which the men have to work. In modern plants it is established practice to spare no expense to make conditions safe and eliminate accident hazards, providing plenty of light everywhere around machinery and plenty of space in keeping the stations clean. The additional expense which has been put into stations to improve conditions has given a high return on investment and this factor alone has contributed in a very great degree toward efficiency.

In conclusion a word may be added to point out that although we have been moving toward greater efficiency in operation we have not reached the end in this direction. Even in the most modern stations only about 17 per cent. of the latent heat stored in the fuel is transformed into electrical energy. The future, therefore, still holds a chance of redeeming in some new station some part of the loss 83 per cent. which at this time can not be overcome.

OTTAWA LODGE C. A. S. E.

Ottawa lodge No. 6 C. A. S. E. held an open meeting in their hall Corner Bank and Frank sts. on Wednesday evening April 36th which was a great success both in attendance and valuable information.

Mr. D. G. Shearer representing the Dominion Flow Meter Co. Ltd., Toronto, gave a very interesting and instructive lecture on The Flow Meter Co. recorder etc. which was illustrated by lantern-slides and the very able and fluent manner with which he handled the subject went to prove him a master.

There were a large number of members, also a goodly number of visitors present.

During the lecture quite a number of questions were asked and very satisfactorily answered by Mr. Shearer and although the meeting ended late the attention and interest given the lecturer went to prove that the subject was much appreciated by all present.

Ottawa Lodge has changed its night of meeting from the 2nd and 4th Wednesday to the 1st and 3rd Monday of each month.

On Monday May 1st will be the election of officers for the ensuing year, also the delegates for convention at Kitchener, it being the last regular meeting of the present year.

The Significance of Chimney Draft

Some Notes on the Pulling Power of Stacks, in Relation to Their Height and Area—The Effect of Wind Pressure and Methods of Staying by Guy Ropes

CHIMNEY or smokestacks are built to serve two purposes. Usually the first consideration is the draft required but some thought must almost always be given the question of delivering the products of combustion at a sufficiently high point so that they will not be obnoxious to the community. This latter consideration is often governed by local ordinances, says the "Locomotive."

Draft, or the ability of a chimney to draw air through the fuel bed, depends upon the fact that the weight of a given volume of air or gas decreases when it is heated. To fully explain the principle of chimney draft, resources must be had to the atmospheric pressure. The air or atmosphere in which we live envelops the earth like a great hollow sphere or shell which physicists have estimated is about sixty miles in thickness. Because of the pull of gravity on this envelope of air a pressure is exerted upon the surface of the earth which amounts to 14.7 pounds per square inch of area at sea level. The further we go from the surface the less the pressure becomes. For instance, suppose we have a boiler room at the sea level with a chimney 100 feet high. The pressure in the boiler room would be 14.70 lbs. and the pressure at the top of the stack would be about 14.65 lbs. The difference of .05 lbs. would be caused by the 100 ft. of air between the two levels. If we consider the furnace of the boiler when there is no fire in it, the pressure on the under side of the grates would be 14.70 lbs. and on the upper side of the grates it would also be 14.70 lbs. Of this 14.70 lbs. pressure, .05 lbs. is caused, both on the upper and lower side, by the 100 ft. of air that we have under consideration. Suppose, however, that we put a fire under the boiler and that the gas in the chimney becomes so heated and expanded that the weight of one cubic foot is but one-half that when cold. The pressure exerted by 100 ft. of this gas in the chimney would only be one-half its former value or it would be .025 lbs. To this we would have to add the weight of the cold air above the top of the chimney (14.65 lbs.) so that the total pressure in the furnace above the grates would be 14.675. But we have not heated the outside air so that the pressure under the grates would remain at 14.70 lbs. There would then be a difference in pressure on the two sides of the grates of .25 lbs. which would cause air to flow through them. As fast as this occurred, however, combustion would take place thereby maintaining the temperature in the stack and the difference in pressure above and below the grates.

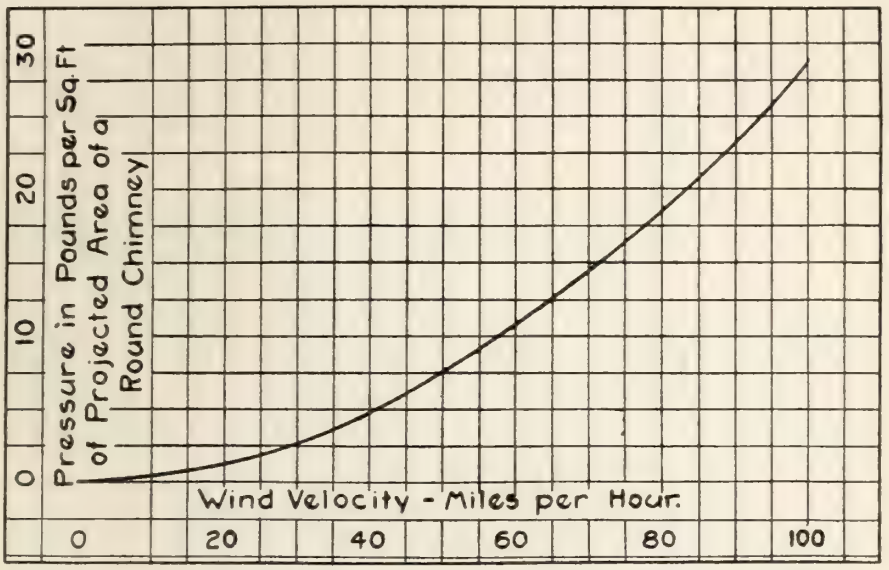


Diagram For Wind Pressure.

Thus we see that there are two fundamental methods of increasing the draft. The one is to increase the difference in temperature between the inside and the outside of the stack. The other is to increase the height of the stack while holding the temperature difference the same. In the interest of economy, however, as much heat as possible must be taken from the hot gases which in turn decreases their temperature and requires a greater height of stack.

The cross-sectional area of a chimney depends upon the kind of coal, the amount to be burned in a given time and the velocity of the gases in the stack. The height depends upon the draft pressure required to burn the coal at the desired rate and also upon the temperature of the gases in the stack. The large number of unknown variables make the field of chimney design a difficult one and proportions that have been found, in years of practical experiment, to give good results are relied upon rather than theoretical formulae. The proportions as given by Kent's Hand book for Mechanical Engineers have been used for many years and are as given in table 1.

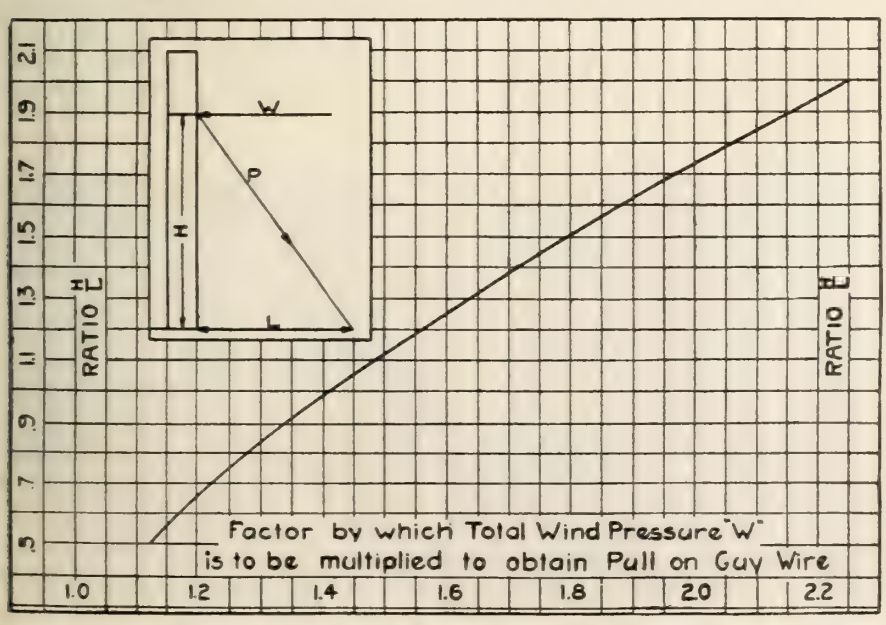


Diagram For Guy Ropes.

Chimneys are built of brick, concrete or steel. The first two materials named are only used for self-supported stacks or those whose weight and design of base are such that no guy wires are necessary. Steel chimneys are also built to be self-supporting but the smaller size steel chimneys are usually braced against the wind pressure by the use of guy wires.

The wind pressure varies greatly with the wind velocity. With a round stack the relation between the two is expressed by the formula $P = .0029\ V^2$ in which P is the pressure in pounds per square foot of projected area of the stack and V is the velocity of the wind in miles per hour. This relation has been plotted as a curve in Fig. 1. From this curve we see that low wind velocities produce but little pressure and that the higher velocities increase very rapidly. A wind velocity approximately 100 miles per hour is classed as "an immense hurricane" and while such a wind storm is unheard of in many sections of the country, nevertheless, engineers base their designs of guy wires on this velocity. It will be noted that a wind velocity of 100 miles per hour corresponds to a pressure of 30 lbs. per square foot of projected area. We might add that by "projected area" is meant the diameter of the stack multiplied by the height. Thus the total pressure on a 100 ft. stack 24 inches in diameter, would be 2 ft. x 100 ft. x 30 lbs. or 6,000 lbs. total.

Guyed stacks are not commonly built in sizes greater than 6 ft. in diameter or 100 ft. in height. They are guyed with one, two or three sets of guys having three or four strands in each set. The greater number of sets of guys the greater, of course, will be the stability of the stack. For general practice it might be well to use one set for stacks 50 feet or less in height, two sets for stacks between 50 and 100 ft. and three sets for stacks above 100 ft. The guys are attached to the stack by means of an iron ring made in sections with lugs and at the lower end are secured to a building or to an anchor, such as a heavy block of concrete, buried in the ground. If but one set of guys is used, the ring in the stack is usually placed at about two-thirds of the height above the base. If two sets are used it is common practice to place one at 2/5 and one at 4/5 of the height.

In determining the size of the guy wires it is assumed first of all that the wind is blowing directly in line with one of the guys. If one guy is used it is assumed to carry the load caused by the wind pressure on all the stack above the guy ring and that on two-thirds of the distance between the ring and the foundation. If two guys are used the upper one is figured for all the stack above its ring plus two-thirds of the space between the upper and lower ring; the lower one is figured for two-thirds of the sections both above and below it.

The guy wires must, of course, make an angle with the stack and the pull on them will be more than the total horizontal force of the wind. The curve in Fig. 3 has been worked out to show the relation between the two. For ready reference the ratio of height to horizontal distance has been plotted instead of the guy wire (See the sketch in Fig. 3). Thus for a ratio of H of 1.4, which represents average practice, the total wind pressure W that any one guy is to carry should be multiplied by 1.5 to obtain the actual pull on that guy. To allow for the initial tension, that must exist even where there is no wind, this assumed load should be increased 50%.

TABLE I.
Size of Chimneys for Steam Boilers.

Diam.	Height of Chimney in feet								
Ins.	50	60	70	80	90	100	110	125	150
	Commercial Horse Power of Boiler								
18	23	25	27	29					
21	35	38	41	44					
24	49	54	58	62	66				
27	65	72	78	83	88				
30	84	92	100	107	113	119			
33		115	125	133	141	149	156		
36		141	152	163	173	182	191	204	
39			183	196	208	219	229	245	268
42			216	231	245	258	271	289	316
48				311	330	348	365	389	426
54					427	449	472	503	551
60					536	565	593	692	662

As an example, suppose that we have an 80 ft. stack, 4 ft. in diameter, to be supported by two sets of guys. The upper set would be placed at 4/5 x 80 or 64 feet from the base and the lower set at 2/5 x 80 or 32 feet from the base. The wind pressure carried by a guy in the upper set would be:—

(16 ft. + (2/3 x 32 ft.) x 4 ft. x 30 lbs. = 3199 lbs.

Assuming a ratio of $\frac{H}{L}$ of 1.4 we must increase this by 50%

3199 lbs x 1.5 = 4798 lbs.

This must be increased again by 50% to allow for initial tension which is the assumed maximum pull that the guy will ever be called upon to withstand. From Table II we find that a 9/16 inch galvanized iron rope would carry the load.

The lower guys would figure as follows:—

((2/3 x 32) (2/3 x 32)) x 4 30 = 2558 lbs. wind pressure, 2558 x 1.5 x 1.5 = 5775 lbs. total,

which would call for a ½ inch galvanized iron wire rope. Note that in the selection of a guy rope practically no factor of safety is assumed other than the remote possibility of the wind pressure reaching a high value and the allowance that is made for initial tension. However, if the wind velocity is 50 miles per hour, which is classed as a "very high storm" the wind pressure is but 7½ lbs. per square feet instead of 30, so that ordinarily, the guy is not heavily stressed. Of course in localities where extreme high wind velocities are common, a larger strand should be used.

The sections of the stack should "shingle" on the inside. This is to avoid, as far as possible, the entrance of water into the joint which might occur when the stack is not in use. To protect the joint on the outside it may be caulked tight. The rivets, for a stack made of ¼ inch plate, would ordinarily be ½ inch in diameter and spaced 2 inches on centers.

Little can be done to prevent corrosion on the inside of a stack but the outside should be protected by a good stack paint and a new coat should be applied from time to time.

TABLE II
ULTIMATE STRENGTH OF GALVANIZED IRON WIRE ROPE COMPOSED OF 6 STRANDS AND A HEMP CENTER, 7 OR 12 WIRES TO THE STRAND

diam. in. Approx.	in. Circum.	Strain in lbs. App. Break.
5/16	1	2800
3/8	1 1/8	3600
7/16	1 1/4	4600
1/2	1 1/2	6400
9/16	1 3/4	8800
5/8	2	11600
3/4	2 1/4	14600
13/16	2 1/2	18000
7/8	2 3/4	22000

UNDERFEED STOKER MOVES

The Underfeed Stoker Co. of Canada announce the removal of their head office from 81 Victoria street to 505 York Building, 146-152 King Street West, Toronto.

(a) Stack wrecked by wind. (b) Gin pole being erected. (c) Gin pole in place. (d.) New stack going up.

Boiler Explosion at Bridgeport

Monday, the second of January, 1922, was a legal holiday in many parts of the country and a large number of manufacturing plants and business houses closed for the day. Celebrations to welcome the New Year were numerous but the forces of nature stole a march on everyone and staged, in a boiler explosion at Bridgeport, Conn., a demonstration that outdid them all. Whether or no there was much temptation placed in the way of those who celebrated the season, certainly much encouragement was given the forces that can be stored in a boiler to show what they could do.

The boiler was an old one—we do not know just how old, but we believe that the age was at least twenty years—of the locomotive type and of lap construc-

Fig. 1.

tion. The metal was severely corroded and, worst of all, repairs had been made by autogenous welding. The owners had bought the boiler, apparently with the best of intentions, from a second hand dealer and probably this dealer sold the boiler with the belief that it was in reasonably good condition. It was said also that an inspector had passed the vessel as being acceptable for a pressure of 100 lbs., and with this belief the owners thought they had secured a bargain. Two months after the boiler was installed, however, the explosion occurred and property damage to the extent of about $8,000 was done.

Newspaper reports stated that the man in charge of the plant at the time had just stoked the furnace of the boiler and had walked a short distance away to turn on an electric light, when the accident occurred. It was said the man was hurled out of the boiler room by the force of the explosion, but miraculously escaped injury.

There were two boilers at the plant and these were placed side by side in a basement over which there was a one-story shed. When the explosion occurred, the barrel-sheet of the boiler was torn off and the remainder—by far the larger part—was hurled up and against the brick wall of an adjoining building, tearing a hole in it and coming to rest in the position shown in the picture above. The barrel-sheet itself was blown up and over the remaining part of the shed and landed in an alley-way between the shed and the next building, as shown in the picture on the opposite page. Just above the third window from the left of the picture the scar may be seen where the plate first struck the brick wall.

A close-up view of the part enclosed by a white circle in Fig. 1 is given in Fig. 2 above and in it may be seen the welding that was done at the junction of the longitudinal and girth seams. The other end of the point is illustrated in Fig. 3 in which the corroded condition of the plate can be fairly well distinguished.

Competent inspection would have shown the danger of using this boiler and the loss in time and money which the owners had to suffer would thereby have been avoided.—Travelers Standard.

After The Explosion.

Fig. 2.

Fig. 3.

TORONTO NO. 1 C. A. S. E.

The Toronto Lodge No. 1 of the Canadian Association of Stationary Engineers held their regular meeting at Cumberland Hall on Tuesday May 2nd, the annual election of officers being part of the business of the meeting. The following gentlemen were elected to hold the various offices for the ensuing year:—

President:—Bro. McLaren.
Vice-President:—Bro. Clewes.
Recording Sec.—Bro. Brown.
Financial Sec.—Bro. Golightly.
Treasurer:—Bro. Soucy.
Conductor:—Bro. Quinlan.
Doorkeeper:—Bro. Thomas.
Trustees:—Bros. Stephens, Fowler, and Quinlan.

After the election business was disposed of, the educational committee took hold of the proceedings, and questions put by the members were answered and illustrated on the blackboard.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field. Steam. Electricity and Refrigeration.

TORONTO, MAY 5, 1922

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The Gas Turbine

WHILE THERE is not a great deal heard about it, the search for the commercially possible gas or oil turbine goes on steadily. As is often the case, the patient searchers are for the most part Germans, this being a line of endeavor that seems to suit their methods. A certain amount of success has attended their efforts, but it has all been along experimental lines, and there is not as yet any machine working in any industrial field.

The gas or oil turbine probably marks the ultimate limit of the possibilities of the heat engine, as the reciprocating triple or quadruple expansion engine marked the limit in reciprocating steam engine practice. It is a noteworthy fact, that in the application of steam direct to the piston of an engine, but little advance has been made from the time of Watt, as far as the principle is concerned. The splitting of the expansion of the steam into several cylinders, which only came after many years, was but a modification which did away with some of the troubles of liquefaction in the cylinder, due to extreme ranges of temperature.

With the internal combustion engine, the full utilisation of the heat of combustion is interfered with by the necessity of keeping the temperature of the cylinder walls down to a point which makes it possible to avoid distortion, and consequent excessive friction, or seizing. This is accomplished by means of water jackets, or as in the case of the Still engine, utilising the latent heat of steam to cool the jacket, by evaporating the water, and then using the steam so formed, to do useful work on the opposite side of the piston.

With the internal combustion turbine, the difficulty has not been to cool the walls of the turbine casing, but to prevent the rotor itself from getting to a temperature at which it would be distorted. This again has meant that the heat of combustion must be dissipated to some extent before the gases are allowed to come in contact with the blades of the rotor. This again decreases the thermal efficiency. In a paper read before a German electrical society these points are explained, and the latest attempts at a solution of the problem explained. This article appears in another portion of this issue of "Power House."

The success of the gas turbine would mean that very low grade fuels could be utilised in gas producers, and the gas thus formed employed to drive a gas turbine at a much higher thermal efficiency than is possible even in the best internal combustion reciprocating practice, and away beyond steam turbine practice. There is no doubt but the difficulties so far encountered will be eventually overcome. It is not so long ago that there were many prophets who insisted that the Diesel engine could never be utilised for large seagoing vessels, but to-day there are hundreds of such ships afloat, and making money for their owners where the steam propelled vessel has to be laid up.

It may not be so very long before we are recording the first successful installation of a gas or oil turbine in a central station or industrial plant.

* * * *

Buying Second Hand Boilers

THE DANGER of buying second hand boilers without adequate safeguards is well illustrated by the account of an explosion at Bridgeport in this issue. We do not mean to say by this that second hand boilers should not be purchased at all, but when they are, it should only be after very careful and competent inspection by a totally disinterested party.

In this case the boiler was of uncertain age, was badly corroded, and further had been autogenously welded. Such a combination would never have been passed by an inspector with any experience and judgment, although it was said that this particular boiler had been inspected. If so, it was probably by an inspector procured for the job by the dealer.

There are plenty of dealers in second hand boilers who would not sell a boiler to a client if they had doubts of its safety for the purpose it was to be used for. There are others, unfortunately, who have no such scruples, but will deliberately misrepresent the condition of the boiler in order to make a sale.

The history of a boiler should always be ascertained when buying it, as this will often help in determining its condition and capabilities. Age is a vital factor, and the usage it has been subjected to is another. Neglect of these precautions let the purchasers of the boiler in question in for a very severe loss, and only by good luck was the loss of human life escaped.

A small fee paid to an inspector of recognized standing would have saved many thousand dollars in this case.

* * * *

Australian Coal

AUSTRALIA is the happy possessor of many fine coal fields, the principal area in New South Wales having a known area of 200 square miles with varying thicknesses up to 27 feet of the very best coal. In Queensland recently a seam, probably the thickest in the world, was proved to have a thickness of at least 93 feet. The coal is remarkably free from ash, says the Communical Intelligence Journal, and the vast seam is pure coal, devoid of any clay bands. The coal varies from 200 feet below the surface to 83 feet only, and at this latter depth, to decrease the cost of mining, it is proposed to use the open-cut system. It is stated that on reasonable borings there are 450,000 million tons of coal proved.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

COPPER PIPES IN SUPERHEATERS

Question:—Why are not copper pipes more generally used in the construction of superheaters?

Answer:—The objection to copper pipe for superheaters is its liability to loss of ductility by constant service and repeated expansion and contraction. It is of lower tensile strength than steel, and costs more. In the high temperatures used in modern superheaters copper is not nearly so reliable as steel.

(2) If 100 B. H. P. be absorbed by a single stage air-compressor, maintaining an air pressure of 100 lb. per sq. in., what B. H. P. could be recovered from a simple slide-valve engine using all the compressed air as a working medium, the engine being 300 ft. distant from the compressor?

Answer.—The power available from an air motor is generally about 45 to 50 per cent. that of the useful work delivered by the engine or motor driving the compressor. Thus in the case given, the work of compression and overcoming friction in the air compressor is 100 B. H. P. which gives about 85 B. H. P. actually used for compression. The distance the air is to be carried through mains to the engines is relatively short, and if the main is of ample size the drop in pressure will be small. If the air is delivered to the engine at atmospheric temperature, the efficiency of the whole system will be about 50 per cent., or the engine should deliver about 50 H. P. If the air is reheated before delivery to the engine then the efficiency will be correspondingly increased. If air is allowed to expand in the cylinder of the engine from 100 lbs. gauge to atmospheric, and its temperature at the starting point is at that of the atmosphere, considerable trouble will be experienced because of the refrigerating effect.

A MENSURATION PROBLEM

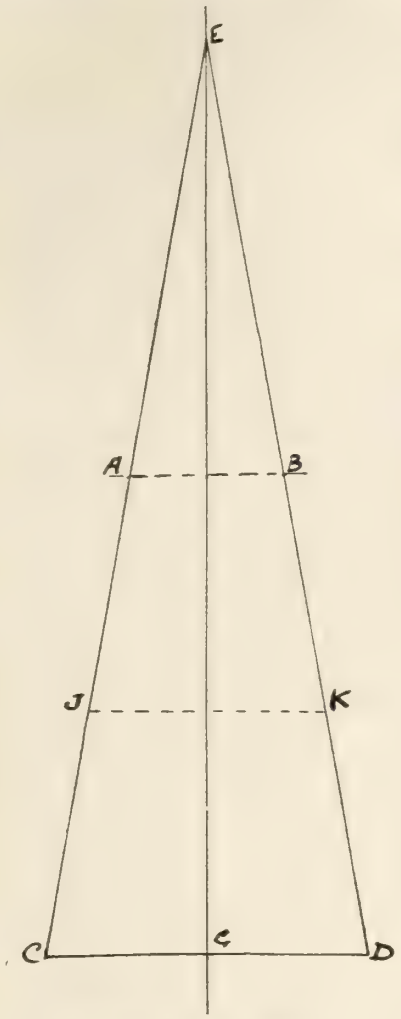
By E. G. W. Montgomery

Re mensuration problem on page 35 of your issue for April 5.

The following solution is suggested as simple and direct.

Complete diagram of plate A C D B to form triangle E C D. Then E F=60″ and E G=120″.

$$\text{Area of plate} = \frac{20 \times 40}{2} \times 60 = 1800 \text{ sq. in.}$$



Extension of plate outline.

$$\text{Area of EAB} = \frac{20}{2} \times 60 = 600 \text{ sq. inches.}$$

$$\text{Area of EJK} = \frac{1800}{2} \times 600 = 1500 \text{ sq. in.}$$

Area of ECD=17800+600=2400 sq. in.

EJK : ECD : :5 : 8.

JK represents line of cut.

$$\frac{EJK}{ECD} = \frac{EH^2}{EG} \quad \therefore EH^2 = \frac{120^2 \times 5}{8}$$

$\therefore$ EH=60×1.581=94.86″.

$\therefore$ HG=120—94.86.

=25.14 ins.

ENGINEERING NEWS

Robt. Gardner & Sons of Montreal, are manufacturing the machinery and equipment that will be installed in the biscuit factory for David & Frere at Maisonneuve, Que. The contract price of machinery will be about $50,000.

* * * *

An entirely new installation of heating and ventilation for the Myrtle Street public school of St. Thomas, Ont., has been recommended by Donald Stewart, consulting engineer, of Windsor and Hamilton.

* * * *

The Robertson Construction Co. of Niagara Falls, Ont, has secured the contract for the erection of a new sub-station for the Hydro Electric Division at Niagara Falls. The cost of the structure will be about $67,200.

* * * *

Reports from Saskatoon, Sask., announce the following contracts closed for construction work. A new chemistry building at the University of Saskatchewan will be commenced shortly, the estimated cost to be about $440,000. Bennett and White of Calgary are the general contractors. Green and Lister of Winnipeg have received the contract for plumbing and heating. Wathton Electric Company of Saskatoon have obtained the contract for the electrical work.

* * * *

Tenders for the masonry, brick and carpentry work on the new civic hospital will be received May 4. The trustees will then call for tenders for heating, plumbing and ventilation of the main building and possibly also for the power house and building for female help, leaving only the nurses' home, plans for which are well under way.

* * * *

The general contract for the construction of the collegiate institute and technical school of Guelph, Ont., has been awarded to the Yates Construction Co. of Hamilton. The contract price, namely $252,500, is to include all work with the exception of plumbing, heating and ventilation. The contracts for the last three mentioned has been awarded to W. C. Edge and Co., of Ottawa, at a cost of practically $54,000. The building will be of reinforced concrete.

The Operators' Point of View

THE ENGINEER

Who works with sweaty brow, and black?
The Engineer.
Who strains his muscles, cricks his back?
The Engineer.
Who cools the bearings, stops the leaks
Makes wheels go round though they be freaks,
And always finds the thing he seeks?
The Engineer.

Who sees the fireman does his work?
The Engineer.
Who sees the boilerman doesn't shirk?
The Engineer.
Who, when the steam is going down,
Will dig right in without a frown
And help the fireman? "Darn the clown!"
The Engineer.

Who needs a temper like a saint?
The Engineer.
Who listens to the engine's plaint?
The Engineer.
Who finds the squeaks, locates the knocks?
Who keeps the whole plant off the rocks?
The Engineer.

Who, when he dies will go to heaven?
The Engineer.
Who'll have his little sins forgiven?
The Engineer.
Whom will Saint Pete a welcome show
And say, "To hell he must not go,
He had his troubles down below,
The Engineer."

R. A. WOODS.

STEAM TRAPS
By James E. Noble

A piece of apparatus used in power plants, be they ever so small, is the steam trap, and very often they receive less attention than any other important attachment in the plant. An expansion trap may be bought and connected by some jobber who neglects to blow out the pipes before making the final connection. Result, pipe scale, pipe joint paint, or dirt, or all three, are blown into the trap. Such a trap usually has a small discharge opening, and a small piece of dirt may close it, and the trap be condemned. If it is a trap containing several valves one or more of the valves may be made inoperative, because of someone's lack of knowledge or care. An improper trap for existing [illegible] used, resulting in its being classed as "no good." A trap of the expansion type should have a fair sized receiver to take care of a sudden rush of water as this type is often slow in discharging when it is a bit warm. In all cases a steam trap inlet pipe should be provided with a strainer and a blow-off valve near the trap. Many manufacturers are alive to the importance of this and supply a combined blowoff and strainer fitting as part of the equipment, the cost being included in the price of the trap. Some provision should be made so that the discharge of the trap can be examined without doing any disconnecting. The trap may have a hidden discharge, it may be blowing steam or it may not be discharging at all. This is one of many points to the credit of the visible tilting trap, as it is impossible not to note whether it is functioning or otherwise. There are many different designs of this type. Some of them can discharge steam steadily when out of order and allow costly leakage if neglected. Very often traps are installed in dark, out of the way corners, and when they get out of condition they stay that way until collected water forces their examination. Usually the trouble can be traced to neglect. Many modern steam traps have proved beyond controversy that they will function properly month after month without one cent of expense for repairs if they are kept clean. I have installed many steam traps and repaired others. In at least 90 per cent. of the repair cases, collected dirt in the trap itself, or in the pipe connections or in the valves was the trouble. Sometimes packing is allowed to harden, or the glands are so over-tightened as to affect the proper operation of the trap. A trap is something like the old reliable duplex pump; its operation is simple and easily understood, given a little care and fair treatment and it will prove a steady worker.

A FEW USEFUL TIPS
By John Thorn

The little bits of knowledge, short cuts to get a certain result, etc., often prove of great value in engineering. Some men make a practice of carefully filing such items for reference, so that they can be located in a few moments when wanted. This means considerable labor, but some particular bit of information is apt to prove just the one thing wanted in an emergency, important enough to pay for all the trouble taken. The items filed for reference should be such as are not generally found in text books or books of standard rules. The following will give an idea of what I mean.

A short rule for finding the change required in the length of belt pulleys when one of the pulleys on which it runs is changed for one of different size, is as follows: Take three times the difference between the diameters of the pulleys and divide by two. The result will be the length of the belt to cut out or put in.

It is generally known that increasing the voltage on an incandescent lamp will make the filament hotter and thus give out more light, but it is not so generally known that the increase in light is greater than the increase in watts, so that the higher the voltage the less the watts per candle power. Of course, adopting this plan would shorten the life of the lamp.

A rule often omitted from text books is one to find the length of a cross belt. To do so, square the diameter of the large pulley and the distance between centres, add together and extract the square root of the sum; subtract from this the distance between centres and multiply the remainder by two and add the distance around outside of both pulleys.

Theoretically a pump will raise water when the surface of the water is 33 feet below the pump plunger and valves. Some writers claim that good results are obtained when the lift is from 27 to 30 feet. My own experience convinces me that a pump will not give satisfactory service, if the lift exceeds 25 feet. It may lift a foot or two more but the flow will be reduced and the necessary power to operate the pump will be increased. A suction air chamber will help some, but from many years' practical experience in pump work I am convinced it will be good business not to exceed a 25 foot lift unless absolutely compelled to do so. As stated, a suction air chamber will be of some help but they have the habit of becoming filled with water just at a time when they should be empty.

Editor's Note:—An air vessel on the suction side of a pump is useful where there are very long lines of pipe between the source of supply and the suction of the pump. In this case the water in the suction pipe attains a large amount of energy due to its velocity, and if no air vessel is fitted, this will

cause violent pulsations and shock.

In the case of a direct lift, an air vessel would be of no service on the suction side of the pump. If there were no friction in the pipe or pump passages, and the pump could effect a perfect vacuum in the suction pipe, then the lift would be governed by the pressure of the atmosphere, and with a barometer pressure of 30 inches mercury, corresponding to 14.7 lbs., the pump would lift water from a depth of 33.8 feet.

In practice from 25 to 26 feet is the maximum depth.

A FEW NOTES

By W. D. Booker

Some years ago we replaced a steam boiler feed pump with a power pump keeping the steam pump for washing boilers, etc. The power pump was a decided success, so when the steam end of our jet condenser needed a lot of repairs we scraped everything but the condenser head to which we attached a power vacuum pump making our condenser power driven. After several years I can safely say the change was a very big improvement.

Later we took down the auxiliary pipe line and tapped pipes into the main steam pipe at the different places where steam was desired. These changes reduced the lost heat so much that the engine room was far from warm during the cold weather, so last fall we installed three heaters. These heaters were connected up with the condenser and carried a vacuum. The steam was drawn from the exhaust pipe between the engine and condenser while the returns were piped into the condenser between the valve decks on one end.

When the condenser plunger moves back on a suction stroke it reduces the pressure, or lowers the vacuum, in the cylinder and between the valve decks, below the vacuum in the condenser head. This difference in pressure causes the suction valves to open and the water to flow in.

By connecting the returns between the valve-decks this lower vacuum was utilized to cause a circulation in our vacuum heating system. A check valve was placed in return pipe close to condenser to prevent water entering on the return stroke of plunger.

Last winter the engine-room was comfortable and the steam for heating it cost nothing.

With a vacuum heating system it takes about three times the heating surface as with a few lbs. back pressure, and the supply pipes should be very large.

STEAM JET CONVEYORS

G. S. Hamilton.

During the past few years the steam jet conveyor as a method of handling ashes is growing more popular among power plant executives.

Wherever it has been introduced, it has been received with satisfaction and favor. It is handling ashes not only successfully, but also quickly and economically.

The steam jet ash conveyor consists primarily of a line of pipe of extremely hard metal laid of 6-8 or 9 inch diameter, laid in a trench in the boiler room floor, or in an ash tunnel, if there are stoker pits. This pipe line leads from the boiler room to a disposal point outside. Intakes for the troduction of ashes are located before each ash pit.

A jet of high velocity steam provides the motive force. This steam jet is introduced into the conveyor system usually at an angle in the line at a point just beyond the last ash intake opening. A specially designed body fitting is provided at this point, so constructed as to not only properly hold the steam nozzle, but also to deflect the flow of ashes around the angle in the line.

The ashes are drawn by suction to the steam jet and thence are propelled by ejection the remainder of the distance along the discharge line.

In operating the conveyor, the steam valve is opened, the plug or cover removed from the intake and the ashes are fed into the system. Clinkers, broken into pieces small enough to enter the conveyor system can be discharged through the conveyor.

Ashes should be dry. It is not necessary to quench them before feeding into the conveyor.

Users of the steam jet ash conveyor like it because of its labor saving abilities. There is no doubt about its merits in this respect. Only in plants having a large accumulation of ashes is an ash handler necessary as usually the fireman handles the ashes as he cleans his fires.

The usual ash handling gang is laid off or put to more productive labor.

Even when its labor saving qualities are not so manifest, the steam jet proves its popularity by its convenience.

Some plants are so located and laid out that even where the fireman may handle the ashes in his leisure moments it becomes a difficult task to do so. Firemen who work under difficult conditions are dissatisfied. They change jobs frequently. The convenience of the conveyors lessens work, adds to efficiency, and produces a better morale.

Cleanliness is a merit of the steam jet conveyor. One well-known manufacturer has so designed equipment that there is positively no flying dust when the ashes are discharged into the usual storage tank. This manufacturing concern backs up their claims by a guarantee written in the contract.

This is a boon to the power plant that is situated in a high class residential district, or is developing power for a works where unusual cleanliness must be observed. Flying ash dust in the past has been an unavoidable nuisance—now the modern plant may avoid it entirely.

Steam jet ash conveyors can be installed in practically 95 per cent. of the power plants developing high pressure steam by coal. An economical installation requires a working pressure of at least 70 pounds. Ashes can be handled at the rate of six—fifteen tons an hour depending on the size of the conveyor system and the general layout effecting plant conditions.

The steam consumption is low, it being necessary to use steam only while the conveyor is in operation. The speed at which the conveyor can be handled reduces the cost of steam per ton to an unusually low figure.

WHERE ATTENTION COUNTS

W. Harris Day

How many managers of power plants would be willing to purchase several hundred tons of coal supply to heat scale-covered boiler tubes? None, of course, but that very thing is being done in many plants without the knowledge of the owners, managers or operators.

It is a misconception to regard scale as something produced only by so-called impure feed water, which either carries a visible sediment or is polluted or fouled. On the contrary, scale-forming ingredients, as distinguished from mud, scum, etc., are not visible and are not usually called impurities at all. Water which produces scale in abundance is known as hard water, scale being formed from various minerals dissolved by the water as it trickles over or thru the ground and discoverable only by chemical analysis. Even soft water commonly contains quite a percentage of "hardness."

It is common opinion that water from the Hot Springs of Arkansas is nearly if not quite the purest water found in nature. Yet that water is impregnated with from 5 to 8 grains of "hardness" to the gallon. Water from ordinary sources may contain as high as 40 to 80 grains to the gallon. When water to the extent of hundreds of thousands of gallons is converted into steam, in a few months, in a single boiler, it is realized that the aggregate amount of scale left behind in the boiler must be considerable.

Unless the scale deposit is unusually heavy, it is likely to escape detection, spread as it is over such a large surface, especially on account of the low visibility and accessibility of the tubes being examined. How scale is often underestimated has been illustrated many times.

The superintendent of a manufacturing company in Charlotte, Michigan, thought that the company's boilers were practically clean of scale and in that opinion was supported by the boiler insurance inspector. Yet, as an experiment, one of the boilers was given a thorough mechanical cleaning and was found to contain 450 pounds of scale, or enough to cause the waste of nearly half a ton of coal a day.

A hotel in Jefferson, Mo., thought their boilers quite clean. Nevertheless, it was decided to remove all uncertainty

(Continued on page 36)

Management of Direct Current Machinery

By M. BARRY WATSON
Director of Engineering, Toronto Technical Schools.

DURING the last twenty years, while the distances to which electric power can be transmitted economically have increased by leaps and bounds. the use of alternating current has become very general in most factories and industrial plants. As a result of this, many operating engineers and mechanics have got into the habit of paying practically no attention to their electrical machinery, because there is so little to go wrong with the common types of induction motors. Consequently many of these engineers and maintenance men have forgotten much of what they at one time knew about direct current operation.

There are on the other hand many factories, office buildings, hospitals, schools, etc., where most of the electric power requirements are met by steam generated power, at a cost, when operated in conjuction with heating systems or some manufacturing processes, lower than the lowest rates charged for Hydro-Electric energy transmitted over long distances.

In these local steam plants it is usually found advisable, on account of the demand for elevator service. variable speed motors, etc., to install direct current in preference to alternating current service. Thus the majority of these local plants are designed to generate direct current, and the engineers in charge of them must be conversant with the proper care and maintenance of D. C. generators and motors in order that satisfactory service and long life may result.

It is not the intention of the writer to deal in these articles with the installation, rebuilding, complete overhauling or major repairing of D. C. machinery; but merely to touch on the general care and operation of these machines to the extent to which such equipment must be regularly cared for and maintained by all those in direct charge of their operation, if it is to be continually satisfactory.

The principle upon which all direct current generators or dynamos operate, is that by which a conductor moving in a magnetic field has an electric current generated in it. A motor on the other hand operates on the principle that a conductor carrying a current in a magnetic field tends to move. Thus they are exactly the reverse of each other in action.

Mechanically motors and generators are very similar in construction, in fact they may be identical, or the same machine may be used either as a motor or generator. Therefore these machines will be treated as one, except where some distinction is especially stated.

Cleaning

Cleanliness is the first requisite for the satisfactory operation of electrical machinery of all kinds. In fact if a machine is kept properly cleaned there is little that can go wrong with it at any time.

The armature or rotating part of all large electrical machines is built with numerous air spaces through it, in order that the air circulating through these at high velocity when the machine is running will carry away the heat generated in the windings. Some of the older types or smaller sizes have the armature enclosed with canvas or cord coverings on the ends of the coils.

The air in all power plants has in suspension small particles of dust, as well as moisture and oil vapor, which when drawn through between the windings of an armature may cling to the surfaces of the air passages. In this way the surfaces which are designed to radiate heat to the passing air become well coated with a good heat insulator in the form of a coating of dust. At the same time the size of the openings through which the air is to pass is considerably reduced, thus permitting a much smaller quantity of air to circulate. For these reasons, the heat produced in the windings is not carried away fast enough to keep the machine cool, and the temperature may rise until the electrical insulation becomes destroyed, or even takes fire. The urgent need of keeping the inter-winding spaces clean is thus evident.

A certain amount of cleaning can be done to the accessible parts of a machine by means of a brush or duuster, but the only way in which the interior spaces can be easily reached is by means of currents of dry, clean air. If a supply of compressed air is available, a hose and long nozzle can be used to advantage. Failing a supply of compressed air, a hand bellows with a long nozzle may be used with good effect. In most plants this blowing out should be done at least once a week, or even daily in locations where there is considerable dust in the air.

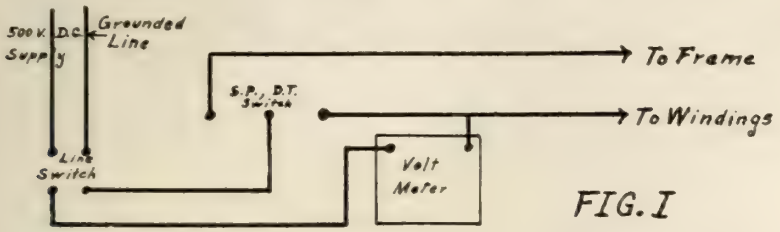
Wiping down should always be done with tightly woven rags, never with cotton waste, as the lint and fibres from the latter are sure to stick to parts of the windings, etc. and collect dust or block the air passages.

Drying

As a general thing the moisture contained in the atmosphere will do no harm to a generator when running, because the temperature of the machine is always higher than that of the surrounding air, thus the moisture in the air will not condense on the machine. If a machine has been stored in a damp location without operating for some time, it will get thoroughly damp throughout the windings. Also electrical machines do sometimes get thoroughly soaked with water, usually due to an accident such as a burst pipe, leaky roof, flood, etc. In such cases the machine must be thoroughly dried out before it is again put in service, because the high leakage of current which would take place through the wet insulation if operated at normal voltage would probably ruin the insulation permanently, or even cause a sufficient current to flow to burn out the machine completely.

If a machine is thoroughly soaked with water, it is best to give it a preliminary drying by means of a draft of hot air if possible. This can sometimes be done by setting up a radiator or

small stove near the machine, and by means of a canvas or tarpaulin cover make a duct for the heated air to go from the radiator through the generator, using some kind of a blower, or even an electric fan, to force the air through. If the machine can be driven by a belt, or another motor, during this process, it will assist in speeding up the drying, but in this case the brushes should be removed, or the field circuit opened, to prevent high voltages or large currents being generated. Machines can be thoroughly dried out in this manner, but the "electrical method" is generally quicker for the final drying. Small machines can sometimes be placed in a hot air duct and dried out quite quickly there.



Wiring for Insulation Tests.

The "electrical method" may be used for machines which are very damp, but not thoroughly soaked. In the case of a generator, the machine should be driven, not over rated speed, with the armature short-circuited beyond the am-meters, and the shunt field rheostat adjusted till the am-meters show not over 125% of full load current. It may be necessary on some types of machines to short circuit, or even cut out of the armature circuit, the series and commuting pole windings in order to keep the current flowing at a low enough value at full speed.

In the case of a motor, the armature may be connected to the line in series with an am-meter and a resistance which can be adjusted to allow not over 125% of full load current to flow. Care should be taken however to see that the resistance is connected to the ungrounded side of the line, to prevent high voltages between the windings and the frame of the machine. In the same manner the field coils may be connected through a resistance in the ungrounded side of the line to normal supply voltage. If the field coils are normally connected in series, it is worth while to reconnect them in parallel to prevent excessive voltages to the frame. The voltage across any field coil should never be more, and generally less than normal voltage across that coil when operating. The armature current can be allowed to flow in the series and commutating pole coils as it assists in drying them out at the same time. The load should be removed from a motor while drying and it should be allowed to revolve if it will.

With the currents mentioned above flowing, the coils should soon warm up to 70 degrees Centigrade or 160 degrees Fahrenheit, and their temperature should not be allowed to exceed 80 deg. C. or 175 deg. F. as the insulation is easily injured by excessive heat, especially while damp.

The temperature rise of the windings can be found electrically, but this method is generally too complicated for the average engineer to bother with. It is generally easier to shut down the machine at intervals and use a mercury thermometer with the divisions on the glass stem. The bulb of such a thermometer can be tucked in between some of the turns of the windings and packed with rags or other poor conductors of heat and left there until the mercury ceases to rise in the stem, this will be a matter of a few minutes, then the temperature can be read. It is well to remember that in closely wound coils the temperature of the inner turns is probably ten degrees or more higher than the outer ones which are in contact with the air.

While it is impossible to determine exactly to what extent drying out has been accomplished, the progress of the process may be watched with sufficient accuracy by those fortunate to have the use of a "Megger" or high resistance meter. There is no standard of insulation resistance for electrical machines, because different makes and sizes of machines give different values of insulation resistance. Previous to drying out a machine, the resistance to the frame from the windings will be comparatively low, this value will gradually increase however as the drying proceeds. The machine can be considered as dry when the insulation resistance ceases to rise with continued heating. The insulation of the field to frame and of the armature to frame should always be tested separately, this requires the disconnection of these parts during the tests. The time required for drying the field coils is generally longer than that required for the armature, on account of the closeness and thickness of the winding on the former.

Insulation tests can be made with a Voltmeter where direct current voltage is obtainable. Connections should be made as in Figure 1, taking care that the frame of the machine is never connected to the undergrounded side of line. A 110 volt circuit may first be used as a trial and if found that the insulation resistance is too high to give any reading when the voltmeter is connected in series with the insulation, as when the double throw switch in the diagram is thrown to the left, it will be safe to use a 550 volt D. C. circuit and a voltmeter reading to 600 volts.

In using the above connections with a Volt meter, the switch is first thrown to the right so that full line voltage is read. it is then thrown to the left, placing the insulation in series with the voltmeter, and the reading of the meter taken. The insulation resistance can be calculated by using the following formula:—

$$R = \frac{r\,(V-v)}{v}$$

Where V = Line Voltage,
v = Voltage reading with insulation in series with voltmeter.
r = Resistance of Voltmeter in Ohms. (This is generally marked on the nameplate, or inside the lid of instrument box.)
and R = Resistance of insulation.

It may require only a few hours running in this way to dry out a machine, or it may be a matter of days or weeks. Without any of the above facilities for noting the progress of the drying out process, it is better to err on the safe side and continue the drying too long. Large machines take longer than small ones, so it is largely a matter of judgment on the part of the operator as to when it is safe to put the machine in operation again without doing it any harm.

Oil in the Windings

Whether condensed from oil vapor in the air, or whether spilled or splashed on the windings of a machine, oil is most harmful. Primarily, if allowed to soak into the windings, it may rot the insulation, and render it both electrically and mechanically useless. On the other hand it holds the dust which it catches, making it almost impossible to remove, thus causing heating.

Care should therefore be taken to prevent the overflow or creeping of oil from the bearings to the windings.

If freshly spilled on the windings, oil can be removed by washing with benzine or gasoline, but these must be allowed to dry thoroughly before the machine is again operated, as a spark at the brushes might easily set fire to any vapor coming from the windings, and cause much damage.

(To be Continued)

TO CHARGE BATTERIES

Question:—I have a 110 volt direct current lighting circuit from which I want to charge automobile storage batteries. Please explain with figures and sketch a wiring circuit in which I can use 40 watt incandescent lamps as resistance to get the correct voltage and current to charge one or more auto storage batteries at one time. What is the discharge voltage and current capacity of a common auto storage battery?

Answer:—If it is desired to charge a small auto starter battery from a 110 V. D C. Main, using electric light

bulbs as a resistance, it would not be economical to use the Tungsten or Nitrogen lamps, as their current consumption is so low that it would be necessary to use such large powered lamps, and so many of them that the cost would be much too high.

The carbon filament lamp consumes many times more current than either of the above mentioned types. A carbon filament lamp consumes about ½ for a lamp of 16 Candle Power at 110 volts and ampere for 32 C. P. at that voltage.

The usual charging rate for auto-starter batteries varies considerably, depending upon the voltage of the battery, and upon the size and number of plates per cell.

These limits usually run as follows:—
3 Amps on a 24 Volt System.
5 Amps on a 12 Volt System.
10 Amps on a 6 Volt System.

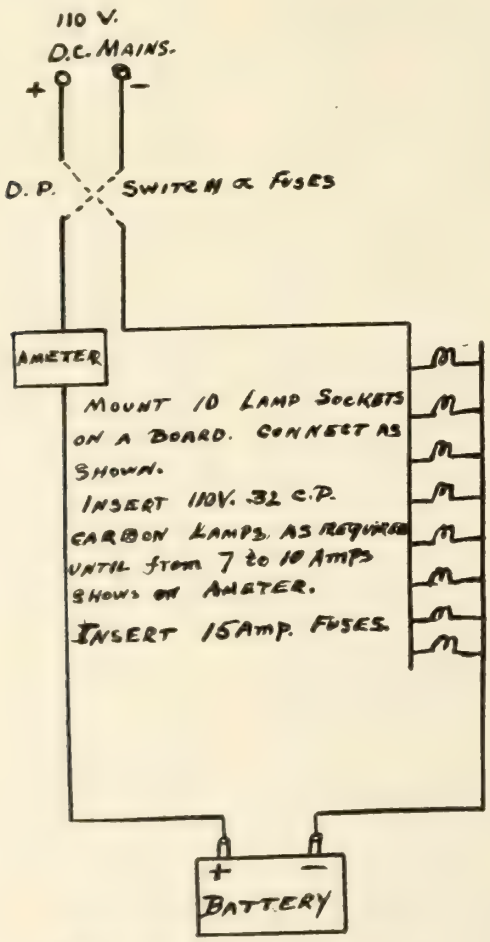
These are the charging rates employed at the beginning of the charge but towards the end of the charge, when rapid evolution of Hydrogen is taking place, the above charging rates must be reduced, or permanent damage will result to the battery.

The nominal voltage of each cell in a storage battery is 2 volts. Each cell in the battery being connected in series, and their voltages thereby being added. It is therefore always possible to tell the voltage of the battery by counting the number of cells and multiplying by two.

This nominal voltage of 2 volts per cell is only whilst the cell is an open circuit, and not delivering energy, or discharging. When the cell is discharging the voltage rapidly falls below 2 volts. This fall again depends upon the rate at which the cell is being discharged, and a limit is rigidly fixed by all manufacturers for the fall of voltage, below which the cell must not be worked. This limit is fixed between 1.65 volts to 1.80 volts depending whether the cell is being discharged at a low rate or at a high rate.

The sketch below will show a cheaply made arrangement for charging an Auto-Starter battery from the D. C. Mains of 110 volts. A more costly and more workmanlike arrangement could be made by placing switches in each separate lamp circuit, but a similar result can be obtained by simply unscrewing the bulb from the socket, whenever the current from a particular lamp is not required.

This arrangement is merely a method of connecting a battery in series with a number of lamps in parallel. Supposing each lamp consumes 1 ampere, by the mere addition of lamps, more current will be allowed to flow through the circuit.



Wiring diagram for battery charging.

WHERE ATTENTION COUNTS

(Continued from page 33)

by cleaning the boilers thoroughly, with the result that one boiler gave up 300 lbs., another 250 lbs., and a third 420 lbs. of scale.

In a tannery in Newport, Tenn., as much as 1000 lbs. of scale were taken out of a single boiler, in spite of the inspector's pronounced opinion that the boiler was comparatively clean. When the result of the cleaning was observed, "We were never more astonished," were the words of one of the officials of the company.

In some plants it is sought to avoid the labor of cleaning by injecting certain chemicals into the boilers and then blowing the boilers down or otherwise removing the scale loosened by the chemicals. These vary all the way from harmless, innocuous substances to the most corrosive combinations. Some think that the right combination of chemicals has quite a bearing on the greater ease or the frequency of boiler cleaning operations; but they are decidedly not a substitute therefor. In the words of one of our leading boiler manufacturers, "for, though a rapid circulation of chemicals will change its character, the most certain cure is periodical inspection and mechanical cleaning."

The evidence of falling scale following such a treatment is no test for thorough cleaning. It is likely that the same test might be applied with similar results, without any treatment at all, by simply turning the force of a good stream into the boilers. This test has misled many an engineer into a false feeling of satisfaction regarding the condition of his boilers.

The rapidity of scale deposit varies of course in different plants, but a rate of 1/16 inch in from two to six months is considered very moderate. Such a thickness, according to experiments conducted by leading experimental stations and research laboratories, indicates a fuel waste of about 12% or 13%, depending somewhat upon the character and density of the scale. An interesting example of the better steaming results accomplished by cleaning the boiler tubes occurred a number of years ago.

A certain coal company obtained contracts to supply coal to a number of plants. After a time, complaints began to arrive to the effect that subsequent deliveries of coal were not so good as the first, that the boilers did not steam as easily as before nor as economically. To meet this objection, the company kept impressing the importance of clean tubes upon its customers and, in a short time, secured the adoption of thorough cleaning methods by most of them. The complaints about coal stopped as soon as the effects of the cleaning were felt.

Another company, in order to secure a coal contract, actually cleaned the boiler tubes of its prospective customer. First of all, a competitor's coal was tried out for a period of two weeks. Then its own coal was to be tried out for the

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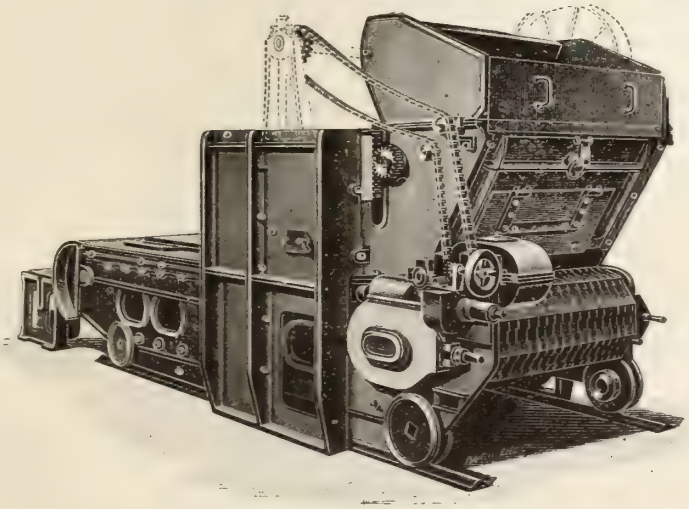
MECHANICAL CHAIN GRATE STOKER



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A good fireman can handfire a 200 H. P. Boiler at ordinary rating, but only the skilled and better-paid men can handle overloads. One man can shovel into the hopper of the B. & W. Chain Grate Stokers all the coal necessary for 1,000 Boiler H. P. or he can attend to 2,500 to 5,000 Boiler H. P. where the coal is fed to the hoppers automatically. Over ratings are obtained with little or no extra effort on the part of the attendants.

Combustion rates may be secured with a B. & W. Chain Grate Stoker which cannot be approached by hand firing methods. The increase in efficiency is the result of the even and continuous firing, the constant air supply, complete absence of the necessity of working the fires and the fact that the coal is burned according to the natural laws of combustion.

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WHERE ATTENTION COUNTS

(Continued from page 36)

same period. But between the tests, the company had a man go into the power plant and, with the aid of a boiler cleaner, remove scale from the tubes. The results from the second test were so much better than those from the first that the contract was secured easily, although the condition of the boilers probably had far more effect than the grade of coal.

Reference is here made to a principle which has proved particularly effective in removing scale, not only from badly encrusted boilers, but from boilers which were thought not to require cleaning. Vibration of metal tubes to dislodge scale is partly an adaptation of an old method. Before the tube cleaners were invented, it used to be customary to insert an iron bar in o or between the tubes and with it knock or scrape off such scale as could be reached. Of course it was not a thorough method and it was hard for the workman, but it was better than nothing.

Today the principle is employed in a decidedly different manner. Instead of hand cleaning, there are mechanical cleaners, and, in place of heavy, intermittent blows, there is a broken up series of light but rapid taps, which play impartially on every bit of the tube walls. All the scale, no matter how tough or tightly adhering to the tube is removed without difficulty by taking advantage of the contrasting nature of scale and metal, the extreme elasticity of the one and the rigidity of the other.

An especial advantage of the vibratory principle is that it can be employed in either water tube or return tubular boilers, to remove encrustation from either the inside or the outside of the tubes, and hard-caked soot as well as scale.

Transfer of heat without loss from the furnace to the water in the boilers is just as important as correct combustion. Yet, ordinarily, where combustion is concerned, thousands of dollars are spent without a qualm for the sake of securing a possible ten or twenty per cent. return on the investment, whereas the problem of transmission is relegated largely to the mechanic in charge of the boiler room; and even his hands are tied within very rigid limits.

Scale wastes affect heat transmission. It is not improbable that very little attention by the management to this phase of power production might well show savings unbelievably large at a cost which would be by comparison absolutely insignificant. The prevention of scale wastes should interest the management as much as if not more than the engineer, partly because the losses are great, partly because they are easily preventable.

REDUCING BEARING FRICTION

The proper lubrication of all bearings, whether they are roll necks or engine slides, seems not to be so well understood by the average run of superintendents as might be the case, as many seem to think that all that is necessary is to supply the machine with grease or oil and let it go at that, the men accepting all wear on journals as an evil which cannot be avoided. It is true that wear on any bearing and journal cannot be prevented, but it is also true that it can be minimized to the lowest possible extent by using the right type of lubricant for differing sets of working conditions among various classes of machinery.

GRAPHITE AS A LUBRICANT

It is well known among lubrication experts, but not by the average run of mill and factory officials, that the consistency of any grease or oil has to be suitable to the weight and rapidity of motion of different machine parts, a lightly constructed machine, such as a watch, requiring a very thin oil to enable it to run. On the other hand, a thin oil proves to be unsatisfactory for roll and pinion necks, as it is squeezed out by their weight before it can get in efficient work. Suet and water mixture is like a thin oil, it being very costly in the end as regards the length of time that rolls can be operated before they are thrown away in the scrap heap. Graphite works on an entirely different principle from oil, and it is the best lubricant of all for heavy machinery in rolling mills. Metals are never smooth.

OBITUARY

Joseph P. Rogers

J. P. Rogers, director of the Queen City Oil Co., died last week at his home in Toronto. The late Mr. Rogers was born in King Township, North York, October 17, 1856, and received his early education in Newmarket High School and Earlham College, Richmond, Indiana. He came to Toronto in 1876, and shortly afterward entered into business with his father, the late Samuel Rogers, and his brother, Mr. A. S. Rogers, under the firm name of Samuel Rogers and Company, and later under the name of the Queen City Oil Company Ltd. He was manager of the lubricating department at the time of his death, and was also a director of the Imperial Oil Co.

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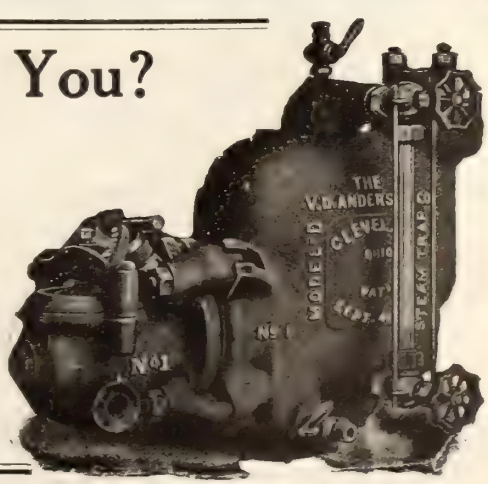

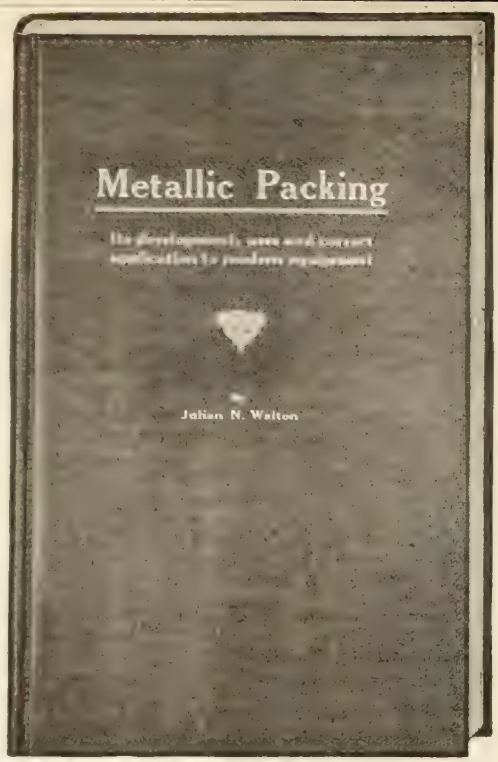

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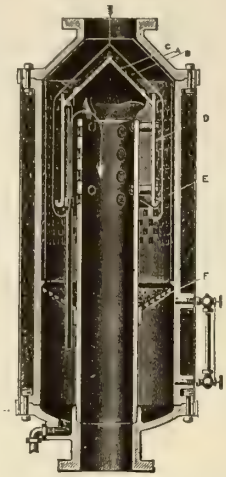

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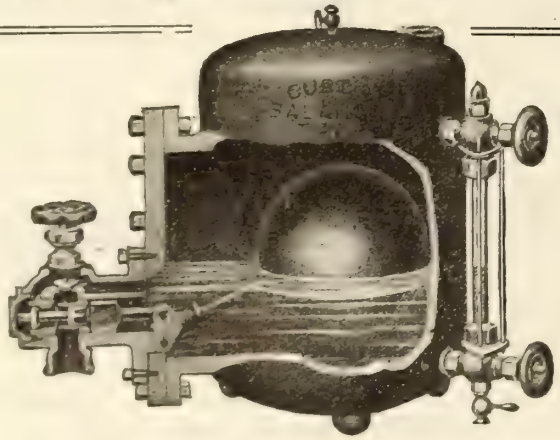

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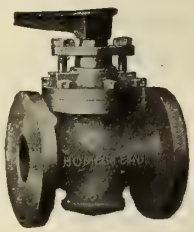

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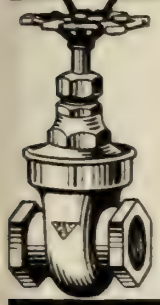

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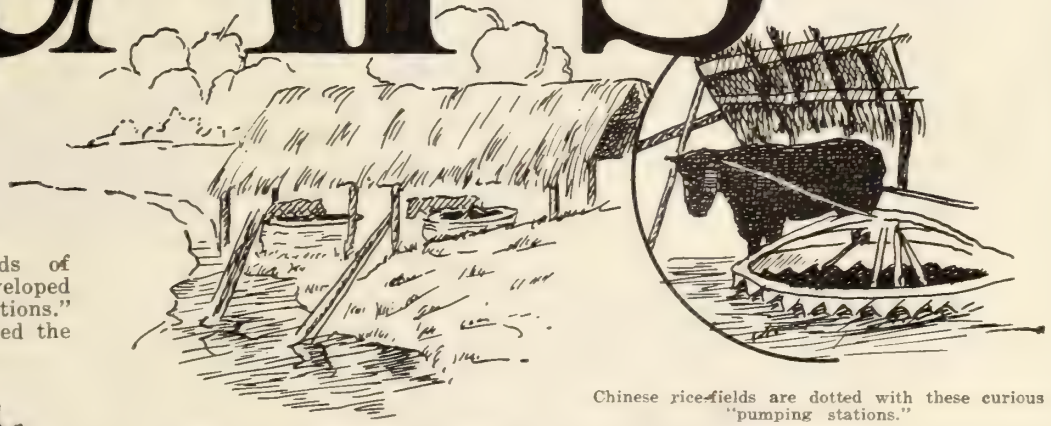
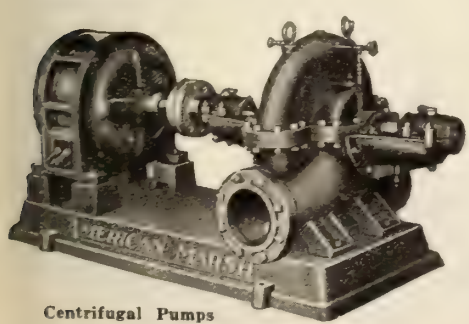


Chinese rice-fields are dotted with these curious "pumping stations."



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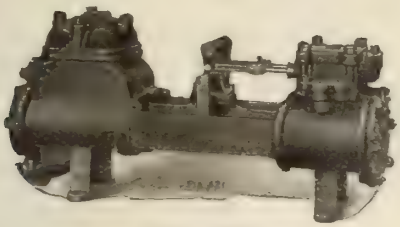

FIG. 7295
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All **made** to gauge. **All parts interchangeable.** Give us an opportunity to figure on your pumping requirements.

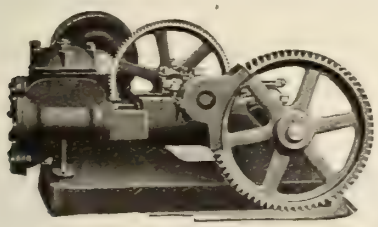

FIG. 7404

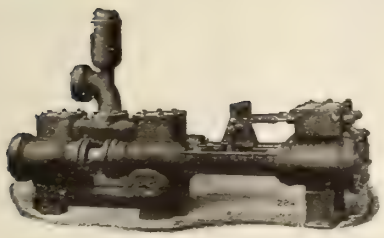

FIG. 7284

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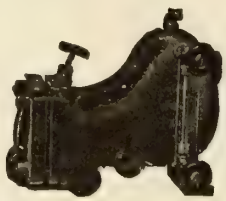

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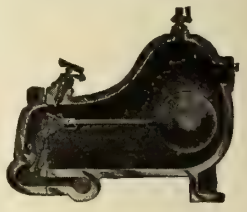

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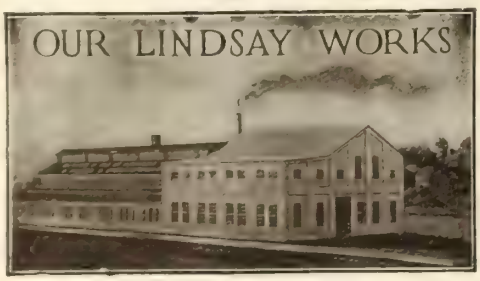

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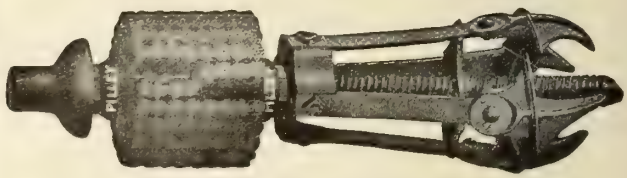

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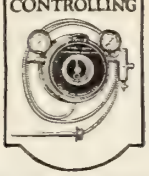

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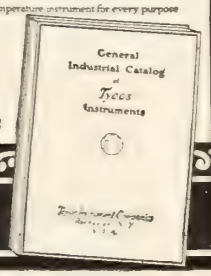

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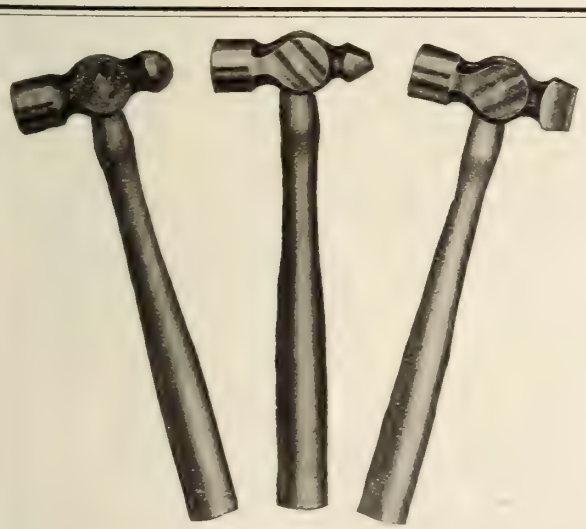

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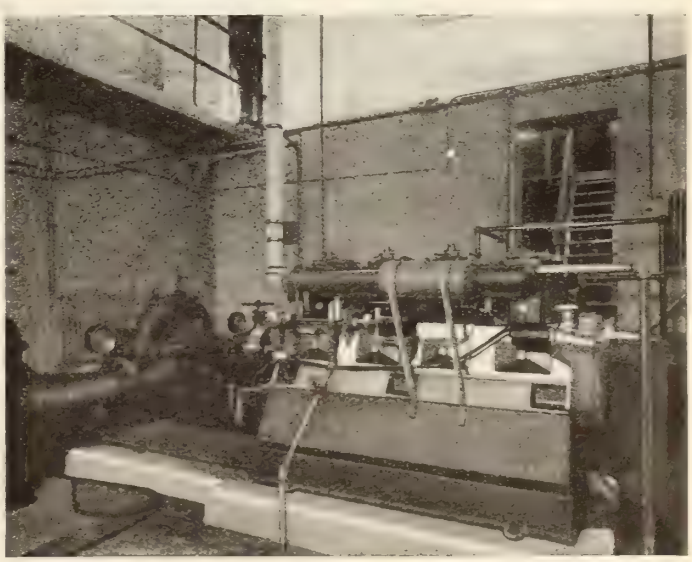

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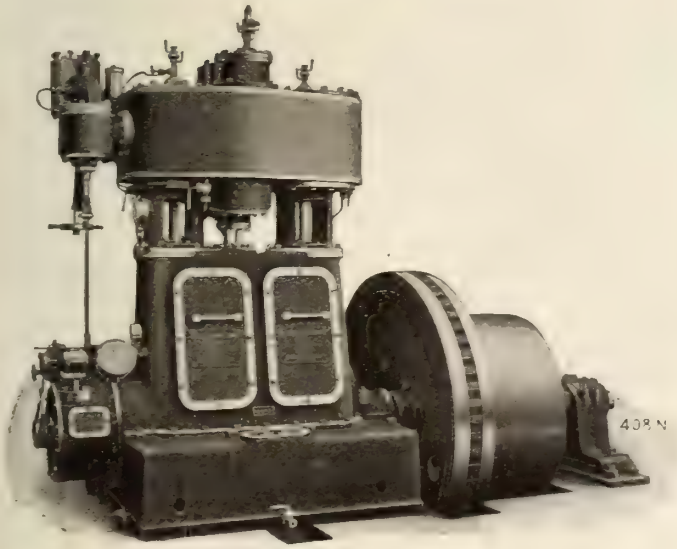

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Waterous Engine Works Co., Brantford.

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Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng Co., Ltd., Montreal.
B. F. Sturtevant Co., Boston, Mass.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co. Brooklyn, N.Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS HOISTING AND CONVEYING
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co. Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co. Ltd., Toronto

HOSE RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.

HOT WATER GENERATORS
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Dominion Steel Products Co., Ltd., Brantford Ont.
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co. Ltd. Hamilton

HYDRAULIC MACHINERY
Bowing Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
MacGovern & Co., Inc., Montreal, Que.

ICE AND REFRIGERATION EQUIPMENT
Bowing Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Jamison Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Johns-Manville Co. Ltd Toronto.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co. Windsor, Ont.

INSTRUMENTS, RECORDING
Taylor Instrument Co., Toronto, Ont.
Yarnall-Waring Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto

INSULATING COMPOUNDS
Johns-Pratt Co., The, Hartford, Conn.

INSULATORS
Johns-Pratt Co., The, Hartford, Conn.

IRON FILLER
Canadian Johns-Manville Co. Ltd., Toronto

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co. Ltd. Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

LACE LEATHERS
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
D. K. MacLaren, Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd. Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
J. H. Williams & Co., Brooklyn, N.Y.

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Johns-Manville Co. Ltd. Toronto.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio

LUBRICATING OIL, FILTERING AND CIRCULATING SYSTEMS
F. Bowser Co., Ltd., Toronto, Ont

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mon.

MACHINERY, TRANSMISSION (POWER)
Can. Mead-Morrison Co., Ltd., Montreal
B. F. Sturtevant Co., Boston, Mass.

MARINE CASTINGS
Mueller Mfg. Co., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murphy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass
Maclean Underfeed Stoker Co., Toronto, Toronto, Ont.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co., Toronto, Ont.

METERS
The Bailey Meter Co., Cleveland.
Can H W Johns-Manville Co., Toronto

METERS (OIL KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto, Ont.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Lincoln Electric Co. of Can., Ltd., Toronto
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont

OILS
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

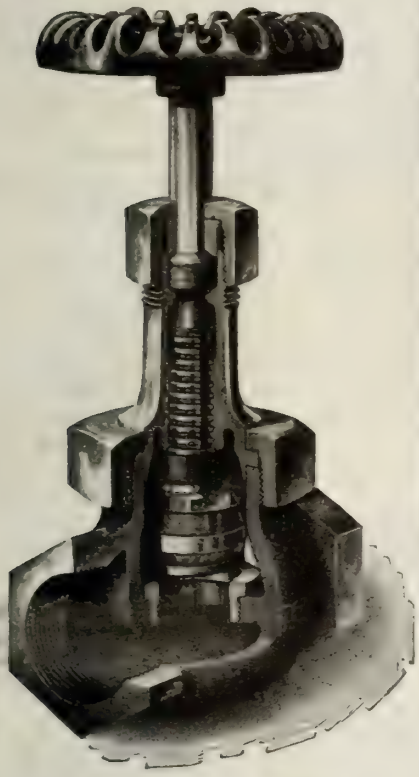
OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

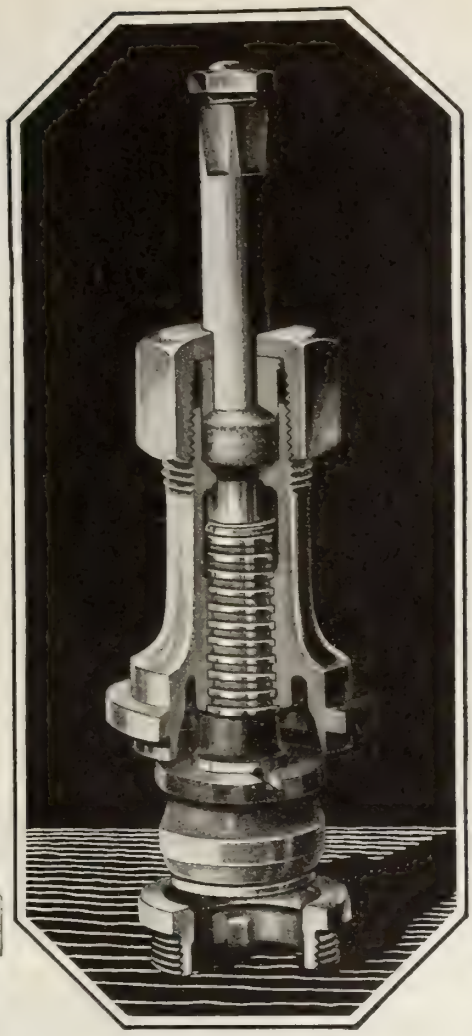
OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
The Mason Regulator & Eng. Co., Ltd., Superheater Co., Ltd., The, Montreal.
Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

"RENEWO"

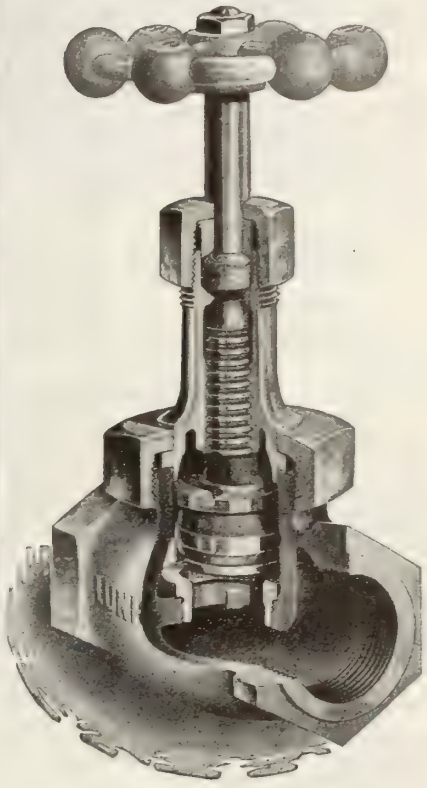
(Bronze Body)
Fig. 73, Medium Pattern
for 200 lbs. W.S.P
Fig. 16, Extra Heavy for 300 lbs.

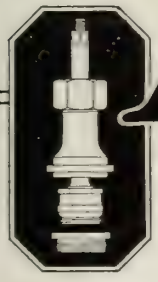




"FERRENEWO"

(Ferrous Body)
Fig. 1021
for pressures up to
150 pounds





Interchangeable

and renewable as well, and this applies to all wearing or bearing parts of Lunkenheimer "Renewo" and "Ferrenewo" valves.

Standardization throughout a plant, with its resultant economies is easily accomplished with the "Renewo-Ferrenewo" combination—"Renewo" Valves for the high pressure lines and "Ferrenewo" for the low pressure lines, with only one set of repair parts necessary to meet any emergency. Both types also embody the well-known Lunkenheimer Regrinding seat feature.

Familiarize yourself with the manifold advantages of the "Renewo-Ferrenewo" combination. It pays.

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"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

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LUNKENHEIMER

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OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg Co., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer Co Cincinnati, Ohio

PACKING, AMMONIA, STEAM AND WATER
Beldam Asbestos (Canada) Co., Toronto.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont
Sarco Co., Inc., New York.
Shell Bar Boiler Supply Ltd Toronto.

PACKING, METALLIC
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
S. F. Bowser Co., Ltd., Toronto, Ont.

PACKING, OIL
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boiler Supply, Ltd., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Pittsburgh, Pa.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
Mfg Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Ltd., Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont

PIPE, SOIL, AND FITTINGS
Crane's Limited Montreal.

PIPE STEEL
Boving Hydr. & Eng. Co. Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydr & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg Co. Toronto
Lunkenheimer Co., Cincinnati, Ohio
Page-Hersey Tubes, Ltd., Toronto, Ont.
York Manufacturing Co., York, Pa.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.
Lunkenheimer Co., Cincinnati, Ohio.

PLUMBING SUPPLIES
Jas. Morrison Brass Mfg Co., Toronto.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
MacGregor & Co., Inc., Montreal.
MacGregor & Co., New York.
Waterous Engine Works Co., Brantford.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd. Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay

PRESSURE REGULATORS
The Fisher Governor Co (Inc.), Marshalltown, Iowa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
Under-feed Stoker Co of Canada, Ltd. Toronto, Ont.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.

PRESSURE AND REDUCING VALVES
Under-feed Stoker Co of Canada, Ltd Toronto, Ont.

PULLEYS
D. K. McLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullough Co., Galt.
Waterous Engine Works Co. Brantford

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, BILGE
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

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Boving Hydr. & Eng. Co., Ltd., Lindsay
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE) CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Smart, Turner Co., Hamilton, Ont

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati, Ohio
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co. Hamilton
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co (Inc.), Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek
Can. Fairbanks-Morse Co., Ltd., Montreal

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co. Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co, Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

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Mason Reg. & Eng. Co., Ltd., Montreal.
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Pratt & Cady, Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal
American Steam Pump Co., Battle Creek
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
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Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's Limited, Montreal.

RADIATOR TRAPS
Sarco Co., Inc., New York N.Y.

RADIATOR AIR VENTS
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Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
Lunkenheimer Co., Cincinnati, Ohio.

RAGS
Shell Bar Boiler Supply Ltd., Toronto.

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S. F. Bowser Company, Ltd., Toronto.

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Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

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MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Canadian Johns-Manville Co. Ltd., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS CO2
Sarco Company, Inc New York

RECORDING THERMOMETER AND GAUGES
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd Toronto.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto Ont.

REFIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Toronto, Ont.

REGULATING VALVES
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
V. D. Anderson, Cleveland, Ohio.
Mason Reg. & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia

SHAKING BARS, ARCHES, ETC.
Sanford Riley Stoker Co., Worcester, Mass.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto
Toronto.

EXPANSION ENGINES SINGLE, COMPOUND AND TRIPLE
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal
Waterous Engine Works Co., Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOAP, POWDER
R. C. Miller Oil & Supply Co., Ltd., Montreal

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd., Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co Toronto, Ont

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co. Brantford.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

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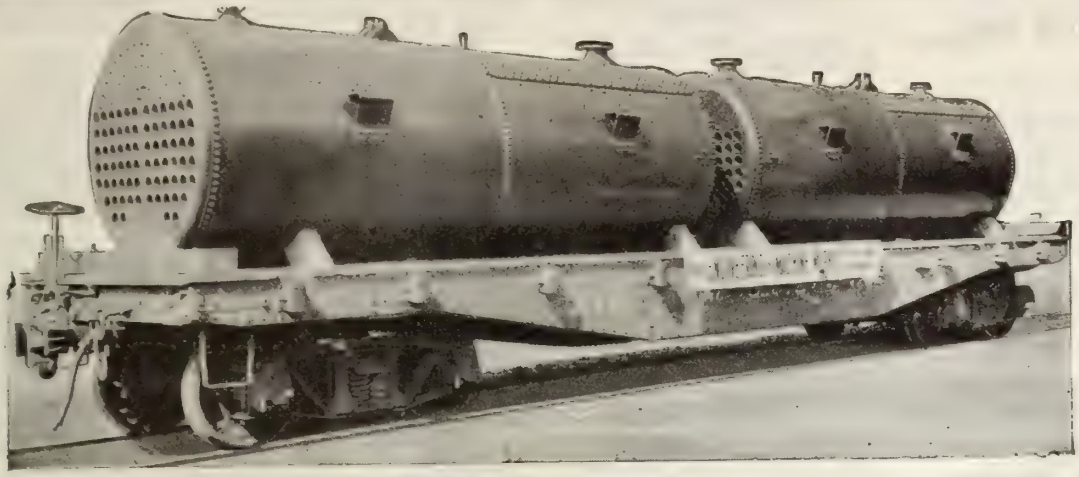

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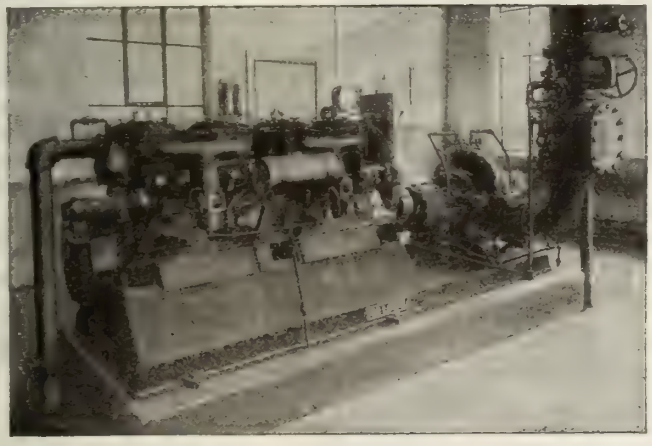

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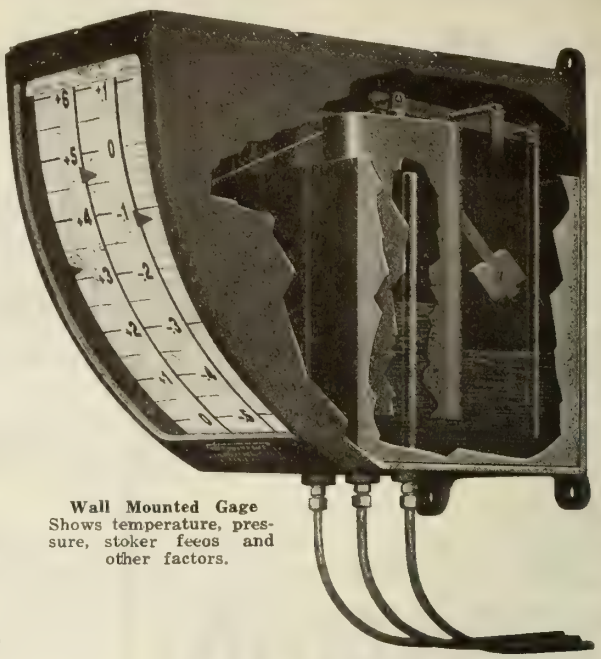

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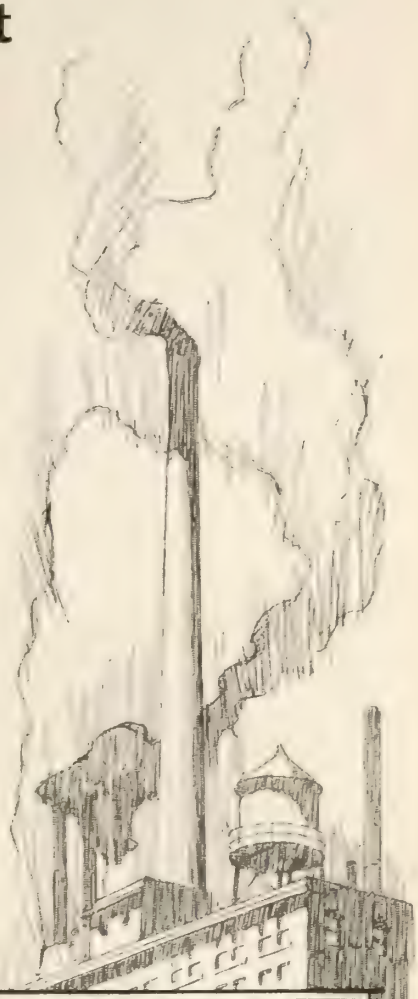

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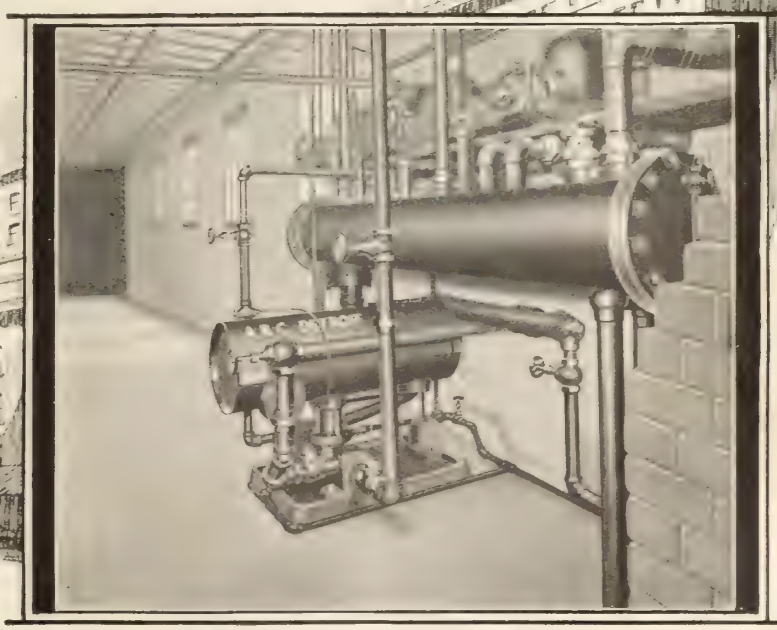

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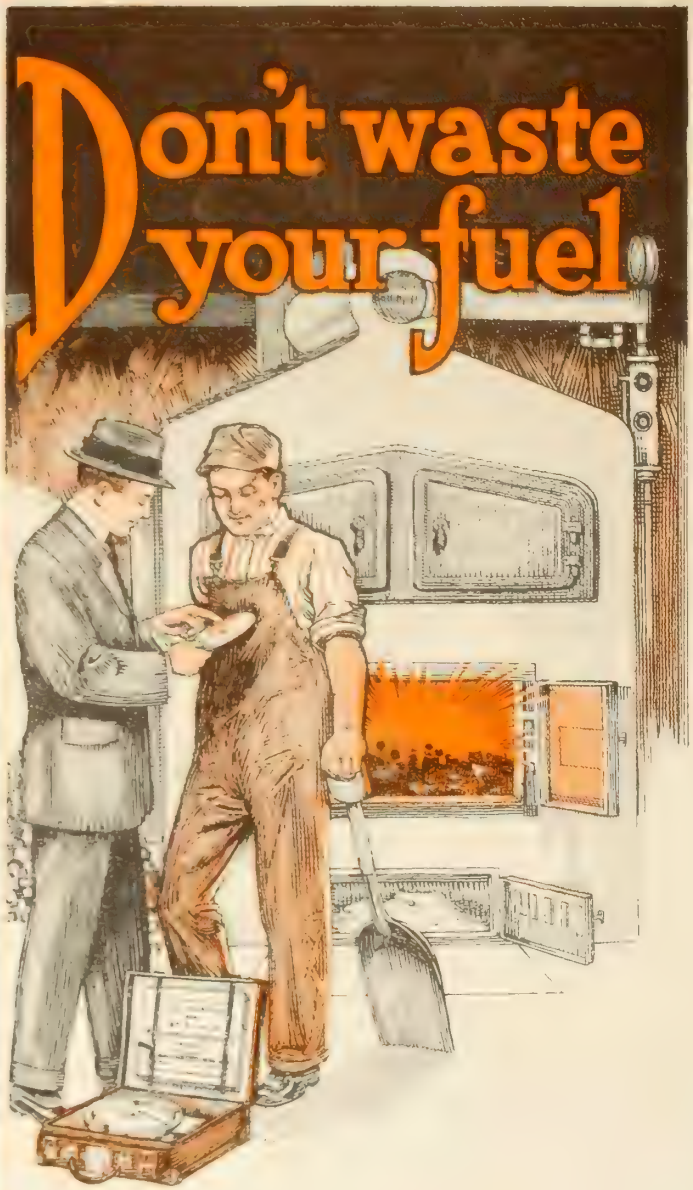

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YOU'RE a practical man but have you ever stopped to figure just how much fuel is wasted through varying pressure?

You know, of course, these interruptions cause a fuel loss, so does the boss—and right there is where the **Morrison Pressure Recording Gauge** benefits both you and the boss.

No doubt you take a pride in maintaining an even pressure all the time—every honest-to-goodness fireman does that. Well, isn't it more satisfactory to you to know that your pressures are accurately recorded, and won't the boss feel better when he can be sure that he is getting a maintained pressure without unnecessary fuel loss?

Some of our lines:

- Stop Valves
- Check Valves
- Reducing Valves
- Steam Traps
- Injectors
- Ejectors
- Inspirators
- Vacuum Gauges
- Lubricators
- Steam Whistles
- Engine Indicators
- Pipe Fittings, Etc.

Every installation is a demonstration of merit.

The James Morrison Brass Mfg. Company Limited

93-97 Adelaide St. W. TORONTO

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto
MONTREAL, WINNIPEG, VANCOUVER — LONDON, ENG.: 88 Fleet Street, E.C. — NEW YORK, BOSTON, CHICAGO

Vol. XV.—No. 10 — Publication Office, Toronto—May 20, 1922 — Published Semi-Monthly Canada, $2; U.S. $2.50 a year

There's a Jenkins Valve for every service. Made of brass, iron and cast steel for steam, water, air, gas, oil and other fluids and vapors.

Here's The Perfect Valve Disc!

A Jenkins Disc—manufactured from high grade rubber and special ingredients, carefully selected and compounded and vulcanized under hydraulic pressure.

A disc that, because of its great flexibility, always forms a perfect contact with the seat giving the valve unlimited life and usefulness under the most severe usage conditions.

While it is important that genuine Jenkins Valves be used where trouble-free service is essential this service can only be assured by the use of Jenkins Discs.

Avoid imitations. Ask for Jenkins Discs by name. At Supply Houses everywhere.

Jenkins Bros
UNITED

5 Retort RILEY STOKERS installed under 487 H. P., G. & McC. boilers.
Smith, Hinchman & Grylls, Consulting Engineers, Detroit.

More Steam at Lower Operating Cost

THE PROBLEM.

At the plant of Hiram Walker & Sons, Ltd., Walkerville, Ontario, more steam was required. Their boiler room contained 10—125 H.P. boilers. These boilers were economically fired but the plant layout in general was inefficient.

THE SOLUTION.

They replaced these *10* boilers with *3* of 487 H. P., fired by Riley Stokers which now gives them ample steam capacity. Although the normal boiler H.P. is increased but little the *actual* capacity is about three times greater because the Riley Stokers will operate the boilers up to 250% of rating or more. *When the above picture was taken two of the boilers were making 200% of rating.*

THE RESULT.

Greatly increased capacity with a *reduction in operating expenses.* The improved power plant layout with automatic coal and ash handling equipment and Riley stokered boilers has made possible a reduction in labor from 8 men to 2 men per shift. This saving in labor alone amounts to nearly $100 per day.

Find out what the Riley can do for you.

Send for Catalog H-5

SANFORD RILEY STOKER CO.

WORCESTER, MASS.

Owners of MURPHY IRON WORKS, Detroit, Mich.

MURPHY AUTOMATIC FURNACES

BOSTON PATCHOGUE NEW YORK PHILADELPHIA PITTSBURGH
BUFFALO PROVIDENCE CINCINNATI CHICAGO

AGENTS

Beeson Machinery Co Kansas City
Stearns-Roger Mfg. Co., Denver, Col.
Robinson Cary & Sands, St Paul, Minn

Files Hand Stokers Getting Results

PANTHER RUBBER COMPANY, LIMITED

GENERAL OFFICES AND FACTORIES
SHERBROOKE, QUE.

SHERBROOKE, CANADA September 23, 1921.

The Waterous Engine Works Co. Ltd.,
Brantford, Ont.

Gentlemen:

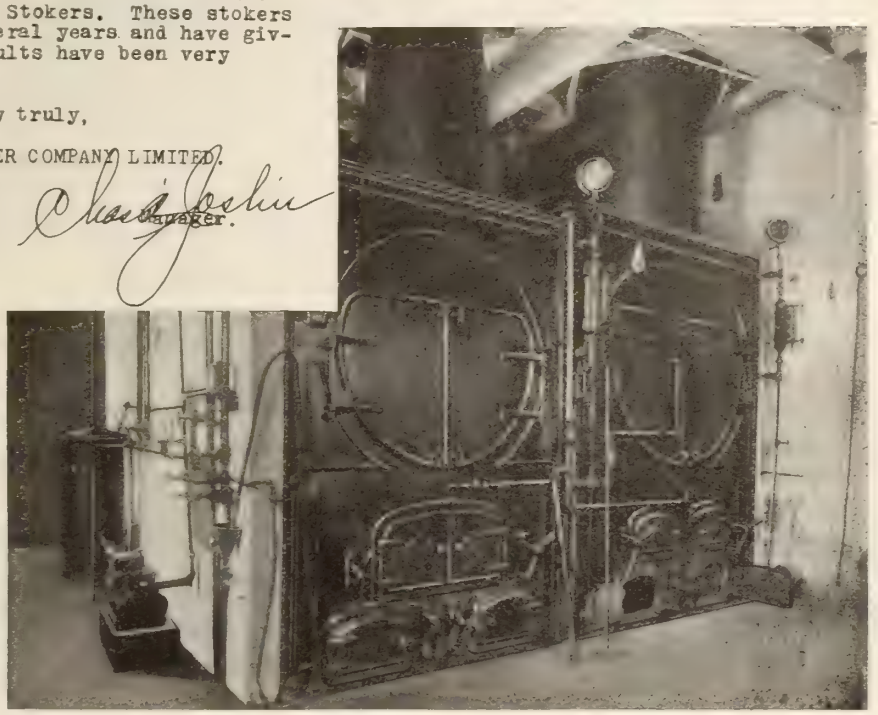
In reply to your letter of the 8th instant we have in our plant the Files Stokers. These stokers have been in operation for several years and have given excellent service. The results have been very satisfactory.

Yours very truly,

PANTHER RUBBER COMPANY LIMITED.

Manager.

CAJ/RMK



It is the uniform excellent service and general satisfaction that have caused progressive men to select **Files Stokers.** These are typical of the more complete data we have compiled:

One installation (3,600 H.P.) saved enough coal to pay for their stoker investment in five months.

A Files installation operated for five months continuously at an average rating of 223%—doubling their steam output.

Files stokers increased efficiency of one plant sufficiently high to warrant discontinuance of two out of eight boilers.

Here is a ready explanation of these achievements:—

1. **Complete volatilization of green coal, causing intensified combustion and smoke dissemination.**
2. **Correct distribution and proper proportion of air according to load carried.**
3. **Fuel bed continuously kept clean, uniform and rich.**

Given the opportunity we will be glad to present these facts for your complete satisfaction.

The Waterous Engine Works Company, Ltd.

Brantford, Ontario

"Dart" Union

BRONZE TO BRONZE **PIPE COUPLINGS** AT THE JOINTS

It Is Better To Prevent Leaks First Than To Fix Them Afterwards

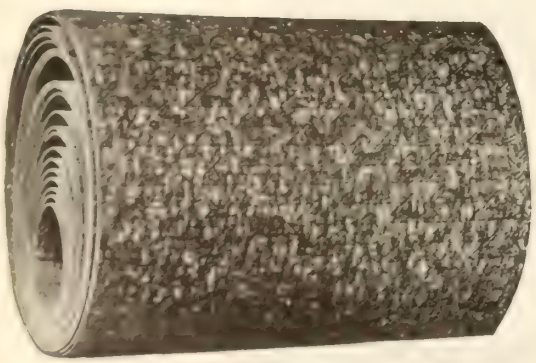
Thousands of dollars have been wasted as the result of leaks in pipe lines. Dart Union connected pipe lines never leak. They are made in such a way as to ensure an everlastingly tight joint.

Manufactured by

DART UNION CO., LIMITED, - - TORONTO

DURABLA

NOW MADE IN CANADA



Durabla Sheet and Gaskets are now made in Canada.

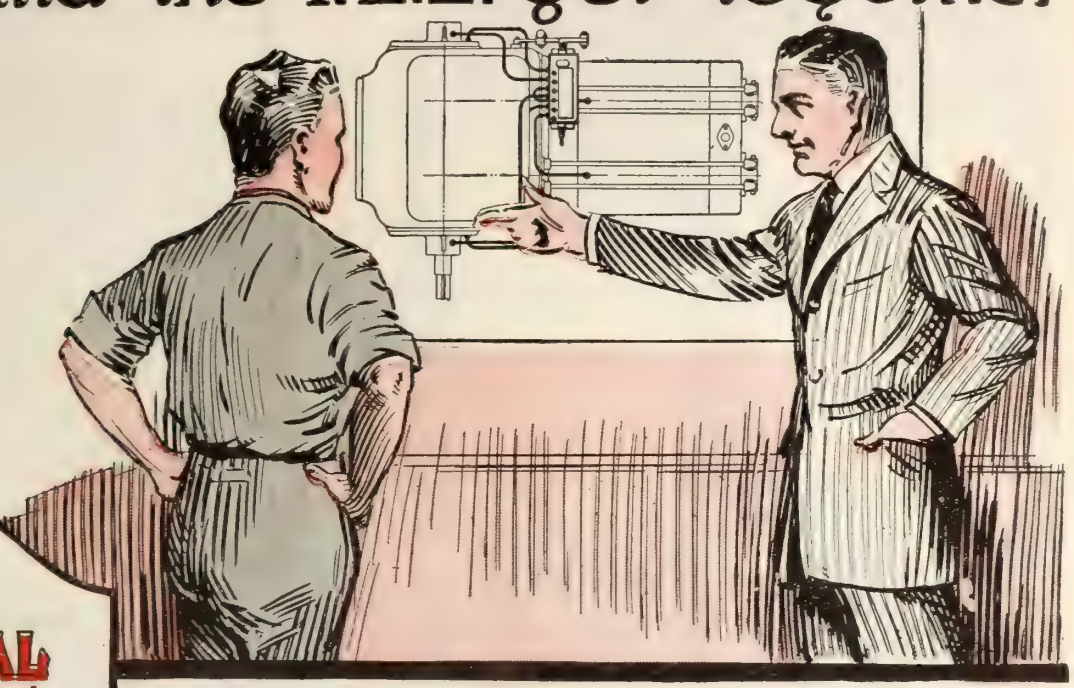
Guaranteed to make a tight joint wherever a permanent gasket is required.

DURABLA MANUFACTURING CO.

Distributed by

The Canadian Fairbanks-Morse Co. Limited

The P.E. and the I.L.E. get together



IMPERIAL Lubricants

FOR MANUFACTURING MINING AND MILLING

CYLINDER OILS

Imperial Cylinder Oil
Imperial Valve Oil
Imperial Capitol Cylinder Oil
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Imperial Beaver Cylinder Oil

ENGINE AND MACHINE OILS

Imperial Solar Red Oil
Imperial Atlantic Red Oil
Imperial Renown Oil
Imperial Bayonne Engine Oil
Imperial Polar Machine Oil
Imperial Ario Compressor Oil

FOR VARIOUS INDUSTRIAL USES

Imperial Black Oils
Imperial Cutting Oils
Imperial Tempering Oils
Imperial Cordage Oils
Imperial Wool Oils
Imperial Greases.

Two heads beat one—that's why Plant Engineers so often call in the Imperial Lubrication Engineer when they are confronted by difficult lubrication problems or want to get to the bottom of an old trouble.

This valuable service everywhere backs up the high quality of Imperial Lubricants insuring their most efficient use. Imperial Lubricants are scientifically graded for every class of service. Rigid economy in production is maintained by standardized use of the right grades.

For details regarding the service which comes ***with*** as well as ***in*** Imperial Lubricants, write to 56 Church St., Toronto.

IMPERIAL OIL LIMITED

Canadian Company—Canadian Capital—Canadian Workmen

Branches in all Cities

T-2749

FISHER
TRADE MARK REGISTERED

Clamp Down on Steam Waste !

Guard your steam as you would your money. Don't let it get away before it gives you every possible ounce of value.

It is an easy matter to make your steam behave if your pump is equipped with the well-known

Fisher Pump Governor

(Type 1.)

For over forty years it has led the field in continuous, dependable service. Many of the "old timers" are still in use.

Made of the highest grade materials—the Fisher Governor will last a life-time. Tested, approved and listed as standard by National Underwriter's laboratories.

Its simple, sturdy construction enables it to function perfectly with minimum attention and repair.

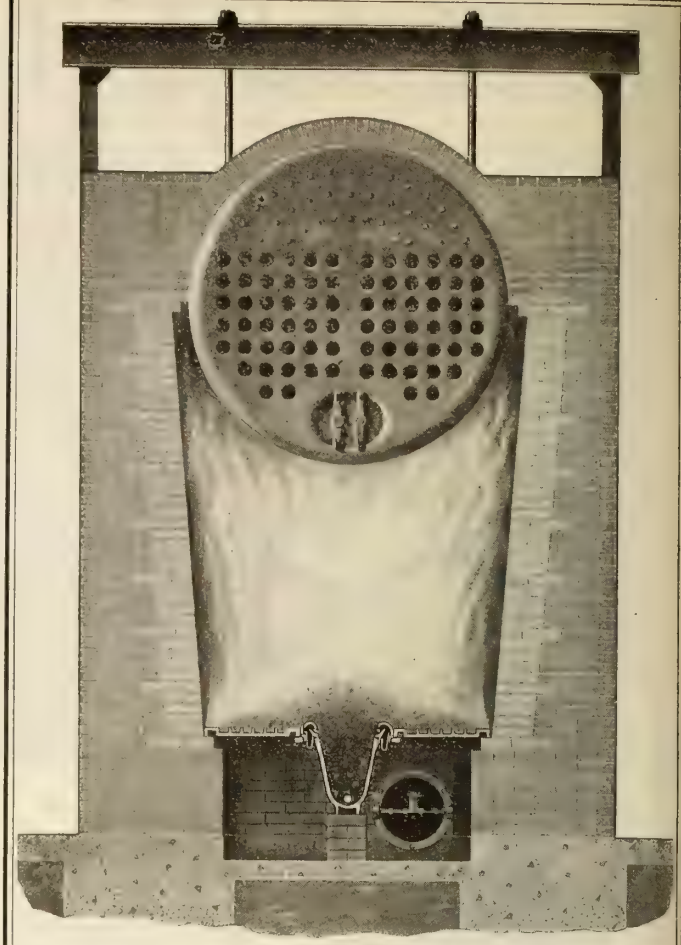
Valve and seats are made of our special formula, hard-phosphor bronze, which resists corrosion and wire-drawing.

When planning new equipment let us quote you prices. Write for illustrated catalog.

The Fisher Governor Co.

933 Fisher Avenue, Marshalltown, Ia.

Agencies in all principal cities.



Reduce Fuel and

Labor Costs with

DESIGNED BUILT AND CONTROLLED BY CANADIANS
TRADE MARK REGISTERED

MACLEAN
UNDER-FEED STOKERS

This sturdily constructed stoker reduces coal consumption and puts an end to power interruptions.

The simplicity of operation adapts it to plants of practically every size. It responds automatically to sudden demands for steam; and a constant uniform steam pressure is carried regardless of varying loads on the boilers.

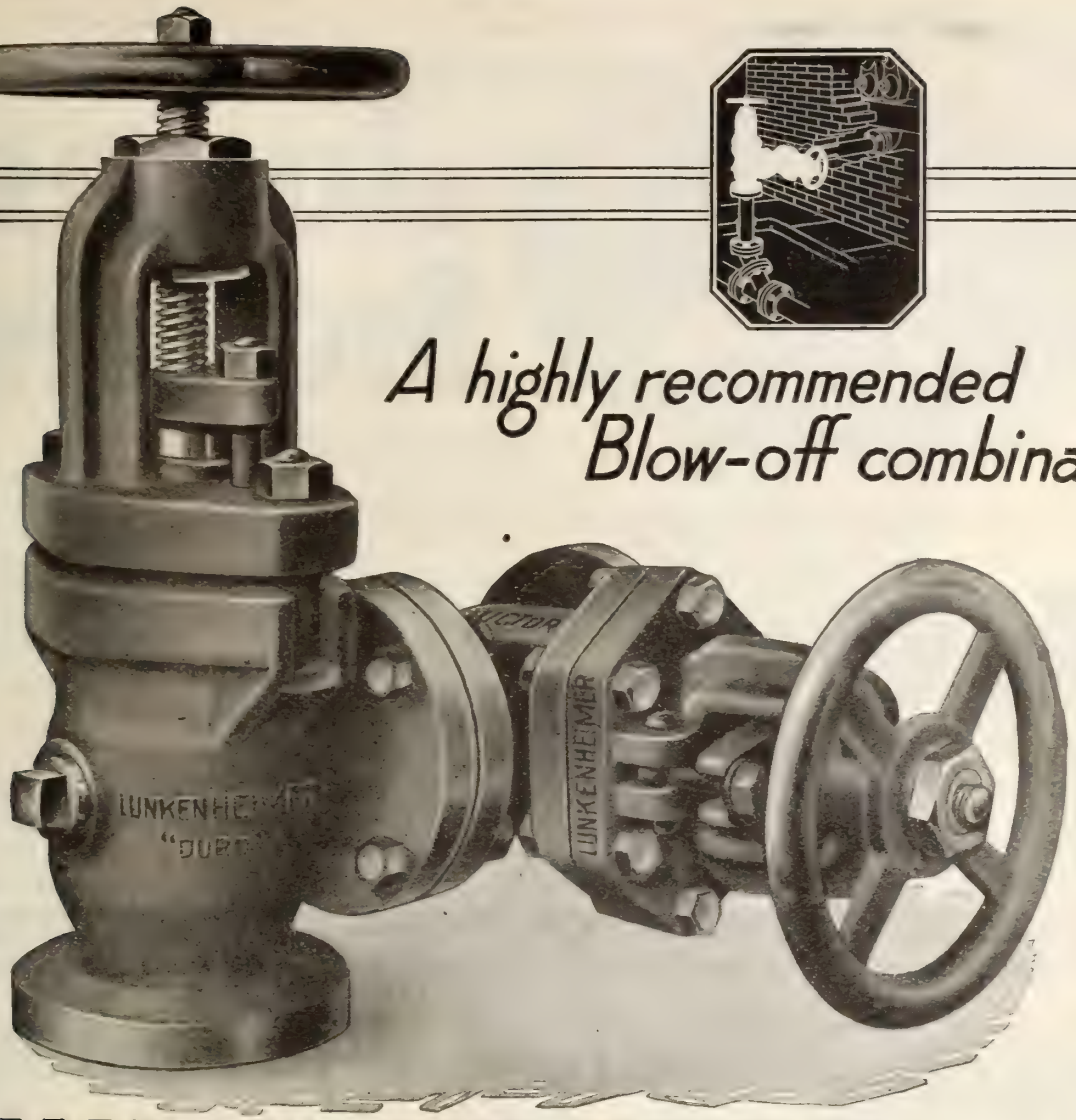
No siftings of unburned coal fall to the ash pit because there are no grates. Small cost of upkeep because no moving parts are in contact with the fire.

The saving in coal will quickly pay for a MACLEAN STOKER. If you operate a steam boiler you should not be without one. Write us for particulars.

MacLean Underfeed Stoker Company, Limited

95-97 King St. E., Toronto, Ontario

A highly recommended Blow-off combination



"DURO" Fig. 897.

"VICTOR" Fig. 892.

LUNKENHEIMER
Blow-off Valves

Remain tight in service, prevent waste through boiler blow-off lines, and thereby turn to a profit the losses caused by leakage which frequently occurs at this point.

In Lunkenheimer Blow-off Valves the water is released gradually due to the peculiar construction of the seat and disc. This virtually makes them safety devices since they eliminate the dangers incident to undue agitation within the boiler or severe shock in the discharge line which result when blow-off valves are opened suddenly.

Lunkenheimer design and construction reduces wear to a minimum. When wear does appear the repair of the parts affected is easily accomplished and when a part is worn beyond repair it can be renewed.

The installation of Lunkenheimer Blow-off Valves is the solution of your boiler blow-off problem. Why not get the facts first hand?

Descriptive literature on request.

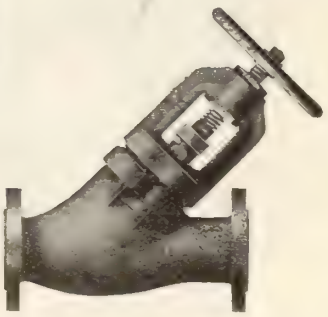


Fig. 1352
Straightway or
Y Pattern

THE LUNKENHEIMER CO
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI, U.S.A.

NEW YORK BOSTON
CHICAGO LONDON

Export Dept. 129-135 Lafayette St.,
New York

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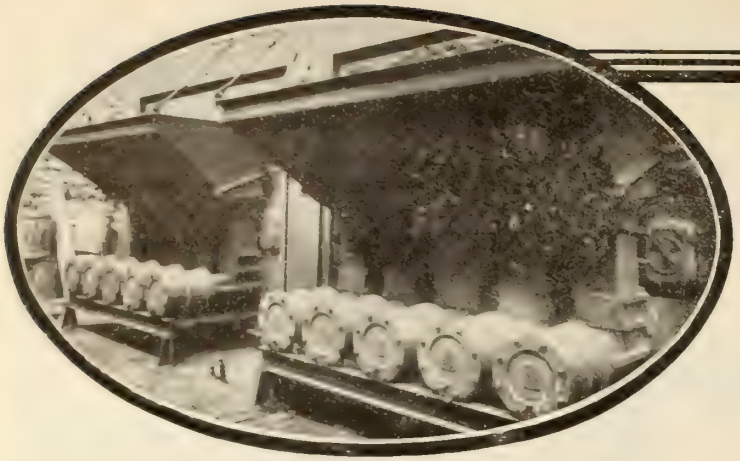
"America's Best since 1862"



Jones Stokers

It's the cost of stoker service that counts—

The Canadian Stoker

Jones Stokers are made in Canada by Canadians and are sold for Canadian money at par. Through special arrangement the extensive engineering resources of the Under-Feed Stoker Co of America are made available for Canadian power users. Thus, this strictly Canadian stoker is backed by world-wide experience and unequalled engineering ability

THERE is just one sound reason for installing mechanical stokers—because they pay dividends; are money makers.

But in spite of the fact that stokers are not an item of expense but a means of saving a few big power users make the mistake of selecting them on a basis of first cost.

You install stokers to save coal—the stoker that will save the most in proportion to its first cost, will, of course, yield the greatest dividend.

You install stokers to increase plant capacity—the stoker that will carry heaviest overloads endlessly, will best fill this requirement, regardless of its cost. You will find that stoker is the Jones "A-C."

You install stokers to save labor—not alone operating labor, but repair labor as well—the stoker that functions automatically and requires least repairs is the best investment.

The Jones "A-C" costs no more than other stokers intended for the same service—and it pays a greater dividend in countless ways.

The Jones "A-C" catalog explains how the Jones Stoker pays for itself—then pays dividends. Write for your copy.

The Under-Feed Stoker Co. of Canada, Ltd

146 King St., West, Toronto.

Quebec and Maritime Provinces — The Cleaton Co. (Canada) Ltd. 403 Southam Bldg., Montreal

British Columbia. — E. A. Earle, Limited 846 Hastings St. W. Vancouver, B.C.

Alberta and West Saskatchewan — Mr. J. Twomey, Camrose, Alta.

Manitoba and East Saskatchewan — W. W. Hicks & Co., 567 Banning St., Winnipeg.

Bailey Weir Meter

Built Differently—and Better

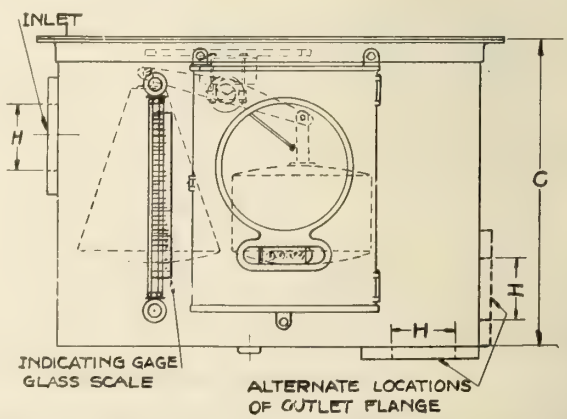
Insuring Freedom from Error

THE accuracy of the V-notch has never been questioned. The standard V-notch is employed in the construction of Bailey Weir Meters, but the construction involves a different principle in recording and integrating the flow than is used in any other meter. There are no cams, springs, racks, gears, roller guides or flexible connections used in the Bailey Weir Meter.

ANYONE who has had experience in calibrating V-Notch Weir meters or doing any hook gauge work in connection with them knows of the great difficulty of accurately determining the true zero level. An error of a few hundredths of an inch at this point may mean as much as 5% error in the flow reading at the higher rates. Any type of recorder where the operating float rises and falls directly with the level of the liquid is open to this serious error.

The design of this Bailey Weir Meter entirely obviates the possibility of such an error, for the relative position of the two displacing members is made right by construction and no changes can possibly take place to alter it.

Bulletin No. 60 explains the advantages of Bailey Weir Meters—write to-day.

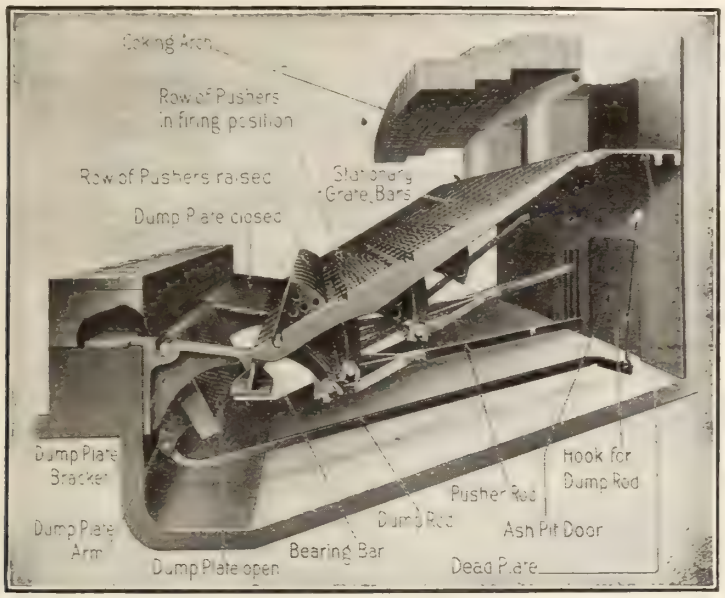


Bailey Meter Company Limited

177 Delorimier Avenue, Montreal, Que.

THE NATIONAL STOKER

Installed under any type of Boiler



With the "coal strike" always with us or being promised you must look to mechanical means to guarantee you the highest possible efficiency in the use of the coal you buy

The highest boiler efficiency and capacity with a given coal and furnace can be realized only when the coal is fired continuously and uniformly and there is no variation in the air supply. With hand firing this requires frequent firing in small amounts, even and skilful distribution over the entire surface of the coal bed, and careful adjustment of the draft. This "close attention" is mighty hard to get. With the National Stoker, high efficiency and capacity are secured with very little effort or skill. Without resorting to the complication and expense of mechanical stokers, the National Hand-Operated Stoker enables relatively unskilled firemen to get economical and smokeless combustion with all kinds of coal, with a minimum of labor. Can easily be installed in your existing plant.

Let us send you full particulars of this economical National Stoker.

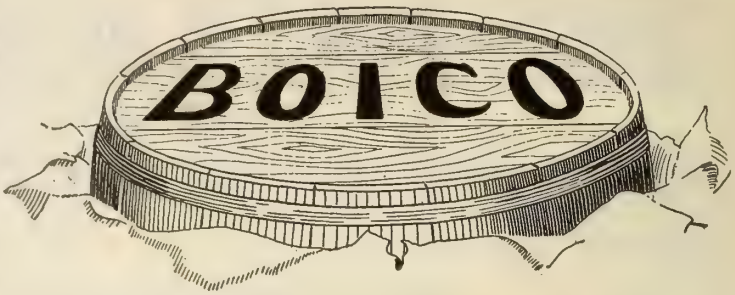
Engineering & Machine Works of Canada, Limited

ST CATHARINES, ONT.

Eastern Sales Offices; Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.



Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 1-15 Saunders Ave., Toronto

Sales Agents: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

De Laval Centrifugal Pumps
For Steam and Electric Drive

THE De Laval steam-turbine-driven centrifugal pump is the cheapest means for handling water. The combined unit costs less than a reciprocating pump, occupies less space and is less expensive for repairs and upkeep. There are no valves, plunger packings, or reciprocating parts to be kept in order. Lubrication is automatic, the same oil being used over and over. The overall efficiency, including all operating costs, is much greater than that of a reciprocating unit.

Two De Laval geared steam turbine driven pumps, and two De Laval motor driven pumps in the plant of the Corporation of Brantford, Ont. The turbine-driven units are designed to deliver 2,800 gal. per min. each against 100 ft. head and the motor-driven units to deliver the same quantity each against 200 ft. head. The turbine driven units can be operated in series, when desired.

For electric drive, the De Laval centrifugal pump is ideal, because of its high efficiency and power-limiting characteristic, which protects the motor against overload. The size of the motor can be chosen to give the highest efficiency at the designed load, which reduces first cost, and in the case of induction motors, results in a higher power factor. The low starting torque permits also of the use of synchronous motors for correcting power factor.

State your pumping problem in detail, including kind of power available, and our Engineering Department will advise you fully. Ask for special publication B100.

De Laval Steam Turbine Co.

Turbine Equipment Co., Limited
73 King Street West, Toronto

The E. Laurie Company
243 Bleury Street, Montreal

Taylor Engineering Co., Ltd.
Vancouver

These Savings Come With

GUTTA PERCHA & RUBBER, LIMITED
TRADE P.M.S MARK
TORONTO, CANADA

No idle machines, or interruptions. Full time of every man on production. Maximum production, free from delays. More profits from the sale of the extra units produced because of efficient transmission by

"P. M. S" BELTING

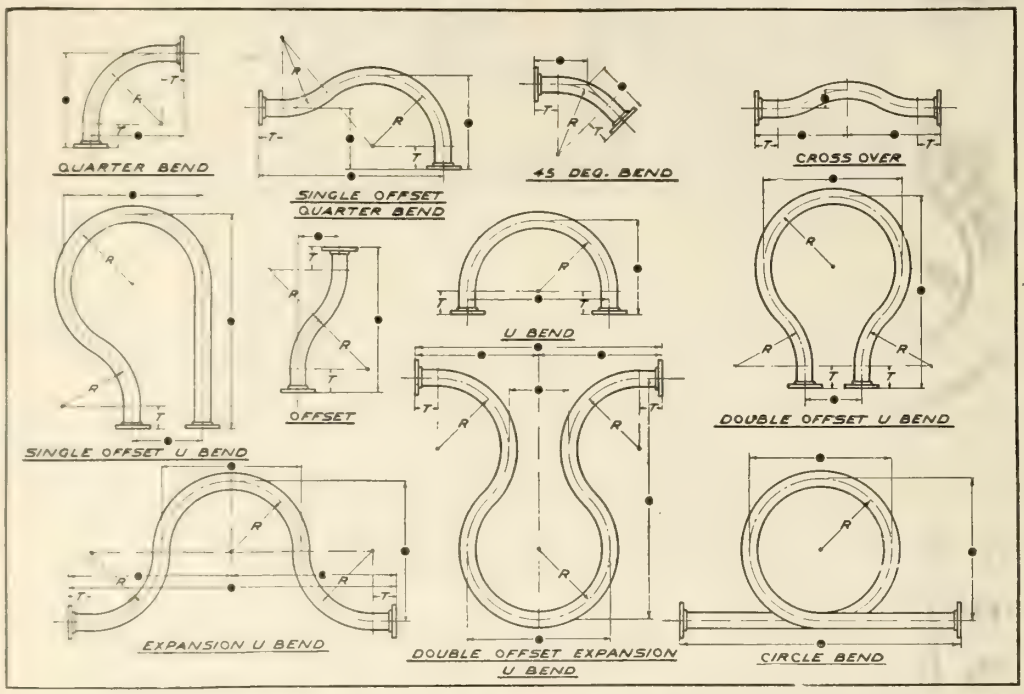
Manufactured exclusively by

Gutta Percha & Rubber, Limited

Head Office and Factory, Toronto

Branches in all Leading Cities of Canada

P&H WROUGHT PIPE BENDS



ALL KINDS AND SIZES UP TO 10" DIAMETER

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

100 Church Street, TORONTO, Ont.

Jamison

HEAVY DUTY
Cold Storage Doors
Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
(Formerly Jones Cold Store Co.)
HAGERSTOWN - MARYLAND, U.S.A.

YORK Ice Making & Refrigerating **MACHINERY**

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO., LIMITED

Villiers and Munition Sts., Toronto — 1415 Whyte Ave., Winnipeg
324 Craig St. West, Montreal — 1158 Homer St., Vancouver

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

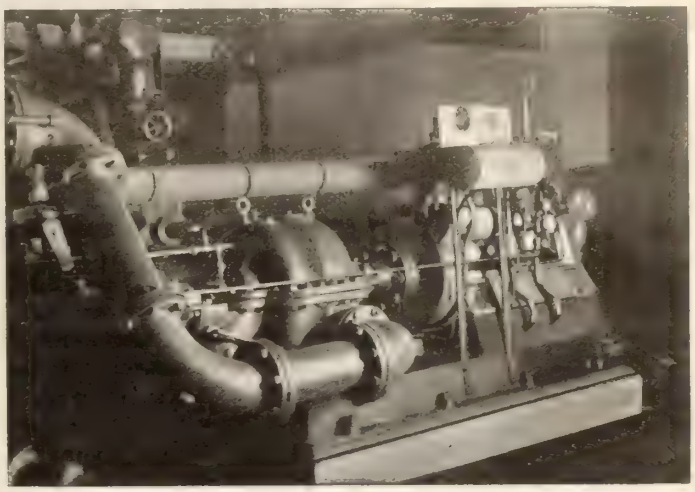
Thomson-Gordon Limited

Engine Packings

Hamilton, Ontario

If You Have No Reserve Power, You Should be Interested in a Set Like This

The maintenance cost of fire in a steam reserve plant of equivalent h.p. would just about pay for a STERLING one year.



4-cylinder STERLING engine at Maywood, Illinois, on a Morris centrifugal pump handling 1,000 G.P.M. at a speed of 1,200 R.P.M. against 60 pounds pressure. Installed by Henion & Hubbel, Chicago, and used almost daily. Keeps down the power rate and assures standby power.

STERLING ENGINE COMPANY

Dept. C-4, BUFFALO, N.Y.

12 ton, 300 H.P., 900 to 1,500 R.P.M.

Dominion Belting Company, Limited

Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO., Ltd., Hamilton, Canada - Quebec Branch: 51 Duluth Bldg., Montreal

Is this hint from a reader Worth anything to you?

A STRIKING message to manufacturers of power-house equipment is derived from a letter written by a "Power House" reader in reply to a request for a criticism of the paper and for suggestions as to how it could be improved. In asking for criticism it was to the editorial portion of the paper rather than to the advertising that reference was intended, and there was no expectation of eliciting such a remarkable testimonial to the paper's efficiency as a medium of publicity. This spontaneous tribute should therefore have a doubly convincing effect. Here is the letter:

Circulation Manager Toronto, April 8, 1922.
Power House.

Yours of April 5, 1922, to hand asking for my candid opinion about Power House. Any opinion other than an honest one is worthless and some parts of the following may not be just to your liking but it is at any rate honest.

I believe Power House compares favorably with other power-house journals in many respects. One department I would like to see at least three times its present size is the selling section. Many of the ads. are from all-American U.S. firms but there must be many others, some of them with Canadian branches and agencies, who do not carry an advertisement in Power House. **This is a mistake on their part,** but for all I know to the contrary it may be due to the lack of energy on the part of the Power House ad. manager in getting after them. **It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages SO MUCH AS ON THE ADVERTISEMENT PAGES.** I write from experience. For the past twenty years I have been first engineer in different government-owned power-plants and I have, time and again, secured ideas tending towards improved conditions in power-plant work from the selling section of Power House. The buyers' directory is good, I would like to see the advertisers index several more pages....."

Suppose you were asked—

by an engineer to tell him something about your products—you would jump at the chance, of course. Well then, do you realize that twice every month some 4,000 such men—men vitally interested in your products—are literally **asking you** to tell them something about your products. That is why these men subscribe to "Power House" (a Canadian journal devoted entirely to Power Plant Efficiency in Management, Equipment and Operation), because they want to know in just what way **your products** will benefit them. **Why don't you tell them?**

We offer you the experience of our Advertising Service Department for the preparation of your messages; in fact for everything from specific information to the planning of an entire campaign. Make use of us; but, before everything else, properly appreciate the unique value of Power House as a medium and make use of it.

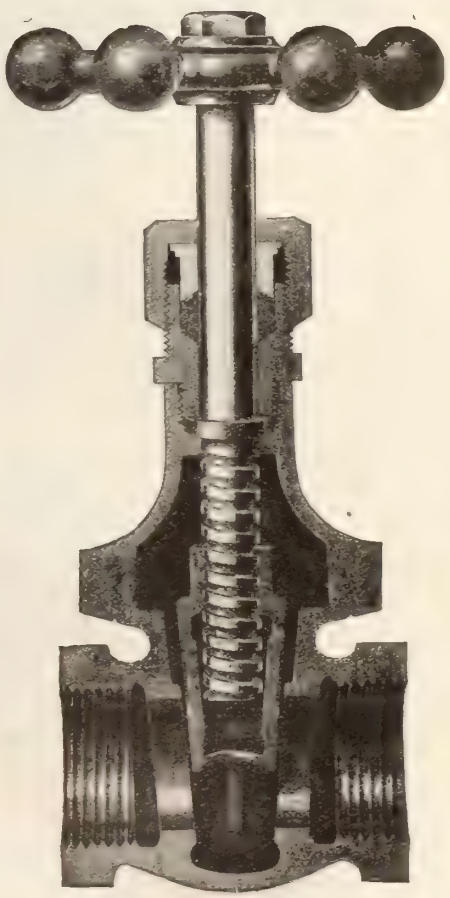
POWER HOUSE

143 UNIVERSITY AVENUE TORONTO, ONT.

PENBERTHY

Brass Gate Valve

For 37 Years the PENBERTHY Trade Mark has been a guarantee of quality to the user of Steam Specialties.



PENBERTHY VALVES

cost no more—but give much more service

Penberthy Injector Co.

LIMITED

Windsor - Ontario

Manufacturers of

Injectors	Cellar Drainers	Grease Cups
Valves	Water Gages	Air Cocks
Ejectors	Lubricators	Priming Cups
Oil Cups	Gage Cocks	Whistles

The Engineer Knows

Style 103

Standardize on one Sheet Packing for all flange requirements. Specify Raybestos always—whether for Engines, Pumps, Air Compressors, Ammonia Compressors or Gas Engines.

Raybestos
Jointing
Tried — Tested — Approved

This is the Jointing that will give you real service on all pipe lines.

It is made from long Canadian Asbestos fibre, compressed under immense pressure. It has given complete satisfaction under gas temperature of 700 deg. and 1,000 deg. F., under hydraulic pressure of 4,000 lbs. per square inch, under steam pressure of 300 lbs. and 625 deg. F. superheat.

Style 665

Redblac Sheet Packing

for Air, Steam, Water, Gas, Marine and Automobile Engines

Sold by

MINE
MILL
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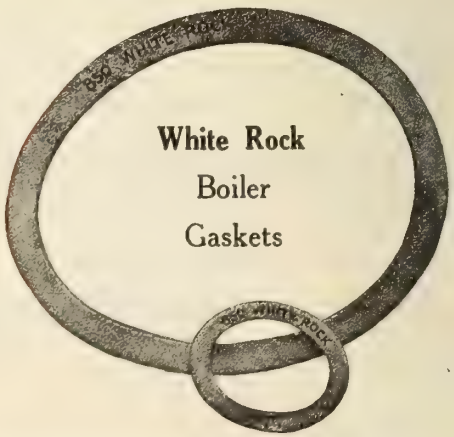

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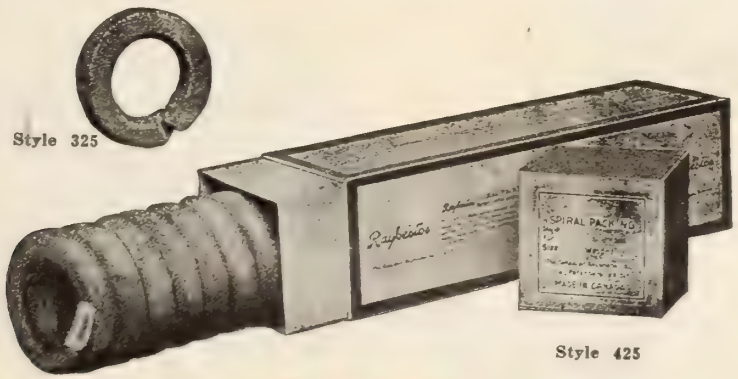

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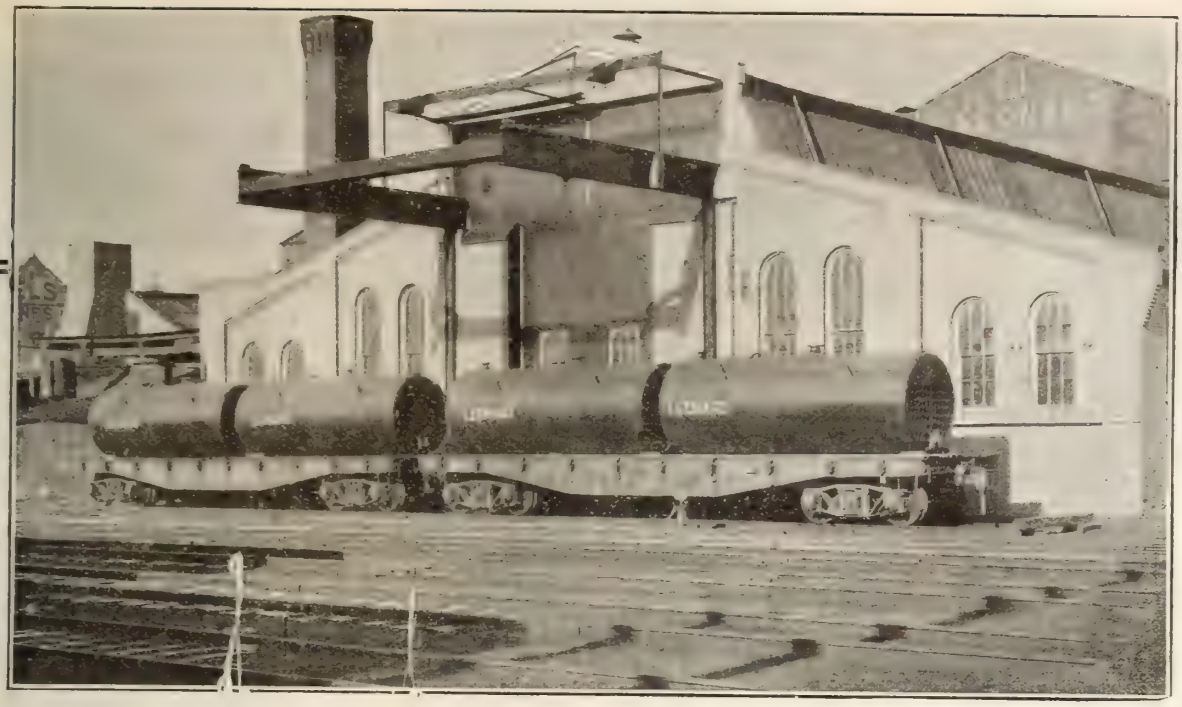

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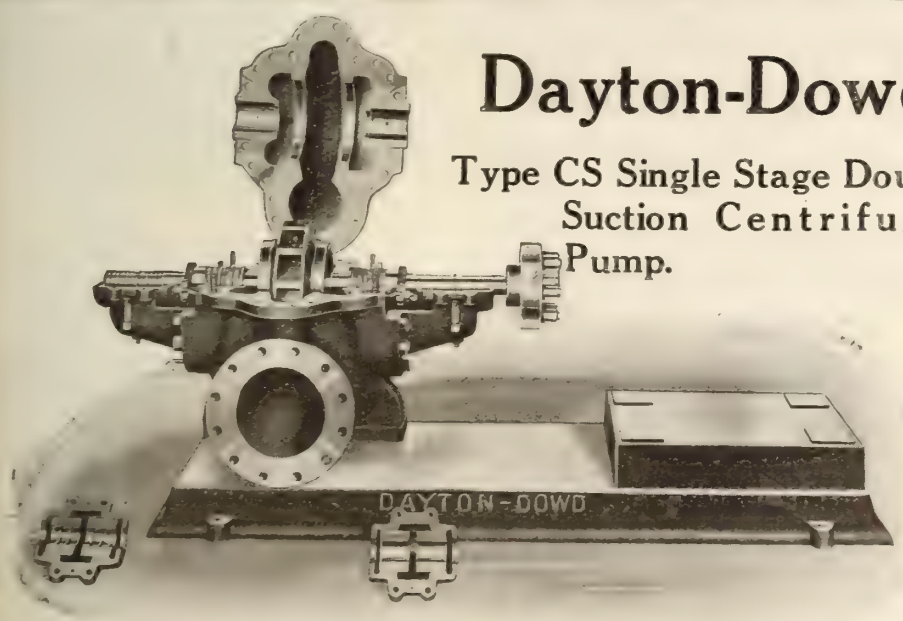

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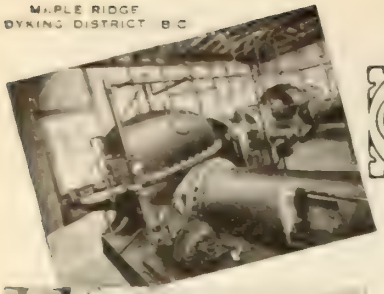
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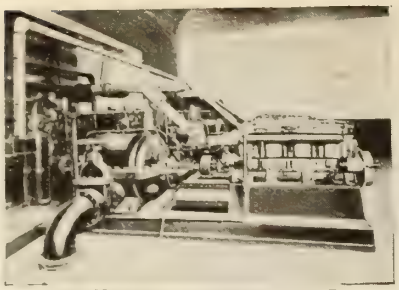
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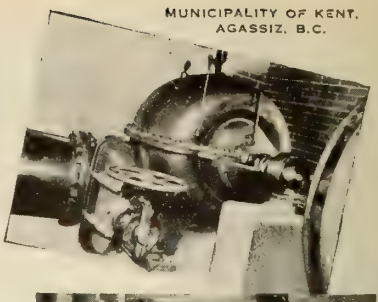
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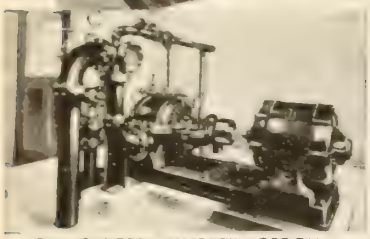
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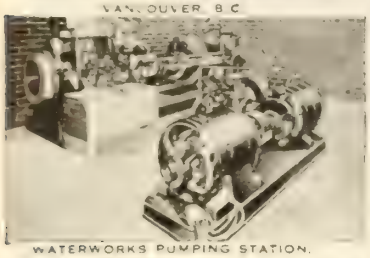
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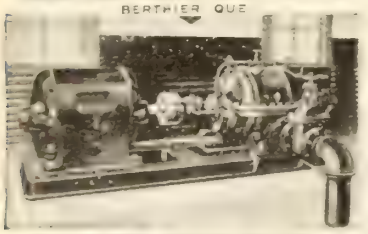
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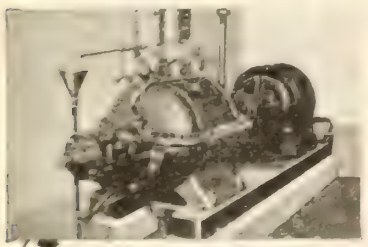
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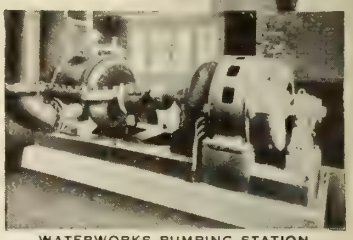
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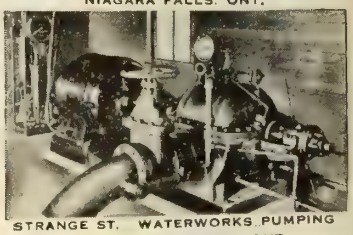
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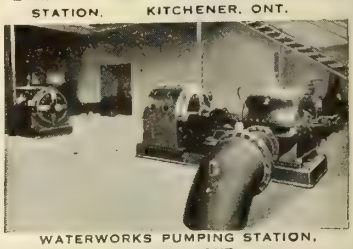
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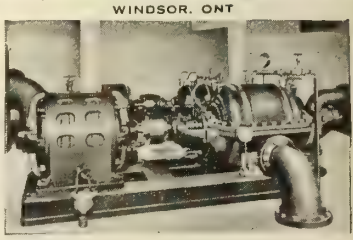
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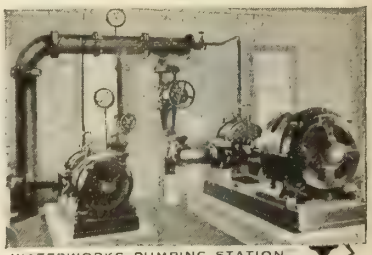
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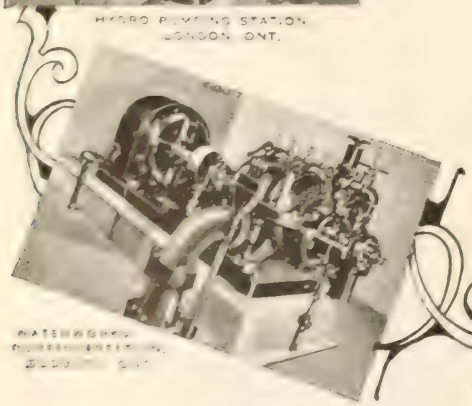
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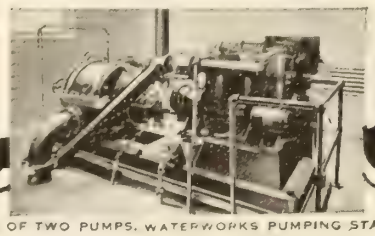
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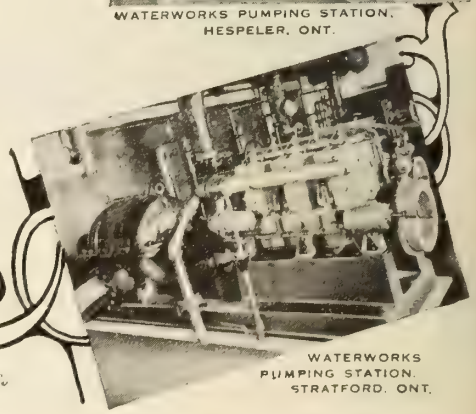
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The Power Plant Journal of Canada

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Refrigeration For The Power Plant Engineer

The Single and Double Acting Compressor, Water Jacketing, Wet Compression and Oil Sealing, Oil Separators, Different Types of Condensers, the Liquid Receiver, Are All Described in This Article

By T. H. FENNER

IN the last article of this series, a general diagram of an ammonia compression refrigeration system was given, showing the compressor situated between the expansion and condensation side of the system. In actual systems, of course, the layout is not exactly so symmetrical as this, but the compressor is of course the central part of the system, whether it is situated in the exact physical centre or not.

Taking this as the starting point we shall describe one or two types of ammonia compressor, both of the double acting and single acting design.

In general, the single acting compressor draws ammonia gas into the cylinder on the suction stroke, while on the return stroke the gas passes through a valve situated in the piston of the compressor, as the piston displaces it. On the third stroke this gas above the piston is compressed and discharged, while a fresh charge of gas is being drawn in on the under side of the piston. Thus after the machine is under way, there is a charge of gas drawn in, compressed, and discharged at each revolution.

In the double acting compressor, there is a suction and discharge valve at each end of the cylinder, and each stroke is a suction and discharge stroke, there thus being a charge drawn in, compressed and discharged, at each stroke, or twice every revolution. In the single acting type, there is a suction at one end of the cylinder and discharge at the other while in the double acting there is a suction and discharge at each end of the cylinder.

Compressors may be vertical or horizontal, and may be driven by a steam engine, or a motor, either direct connected or belted. The steam engine is usually direct connected to the compressor, while the motor, owing to its higher speed, is usually connected to the compressor by a belt. In some cases the motors are direct connected to the machine, but this is usually on small sizes.

A CORRECTION

In the article appearing in last issue, on page 21, column 1, under the subhead "Cooling Effect," there is a typographical error. Instead of 29.4 lbs. absolute, the line reads 294.4 lbs. absolute which is obviously ridiculous.

Single Acting Compressor

Figure 1 is an illustration of a single acting vertical water jacketed compressor. The water jacket is made of sheet metal, and is supported by the bottom flange of the cylinder, which is extended for this purpose. It will be noticed that the water jacket is left open at the top, the effect being that the compressor is surrounded by a tank of water. The water simply overflows, the cold supply water sinking to the bottom of the jacket, making a circulation. The valve at the right hand side is the suction valve, while the valve in the piston is plainly shown. The piston itself is packed by four rings, and the valve seat is secured to the piston by setscrews. A light spring is set on the suction valve in the piston, in order to ensure its seating correctly.

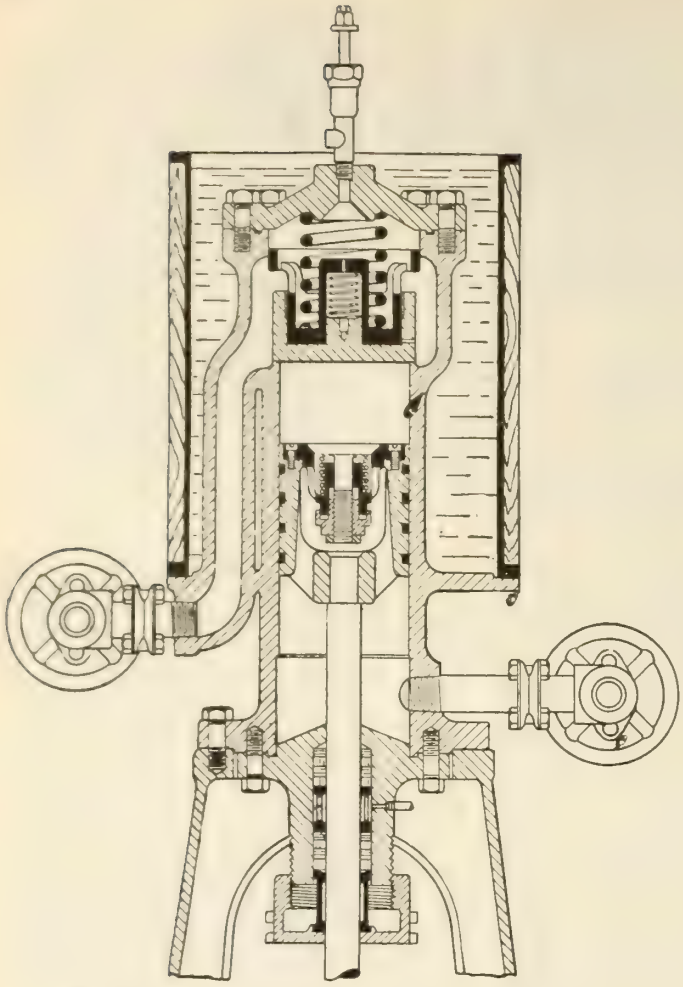
The discharge valve is carried in a casting which sits on top of the cylinder liner, and is held down by a spring. This is known as the safety head and it is so constructed that if anything should get between the top of the piston and this head, the whole thing will be raised against the pressure of the spring thus avoiding any damage to the cylinder cover itself. The discharge port is seen at the left of the compressor, with the discharge valve at the bottom. The piston rod is packed by a special form of stuffing box, known as a lantern, which contains soft packing at each end, and in the centre is an annular bobbin, which leaves a space between the stuffing box and itself, into which oil is pumped under pressure. The small oil connection can be seen in the illustration. Fig. 2 shows another type of single acting compressor, and the construction of the false or safety head is clearly shown in this illustration. The water piping for the jacket is also shown, entering the jacket at the bottom on one side and overflowing at the top on the other side. There is no discharge port in this case, the discharge valve being situated at the top of the compressor cylinder.

In the single acting compressor the stuffing box packing is only exposed to the suction pressure, so that it is not such a difficult matter to keep it packed, the pressure being only from atmospheric to a few pounds above or below. The temperature is therefore fairly constant, and the rod more easily kept cool.

The Double Acting Compressor

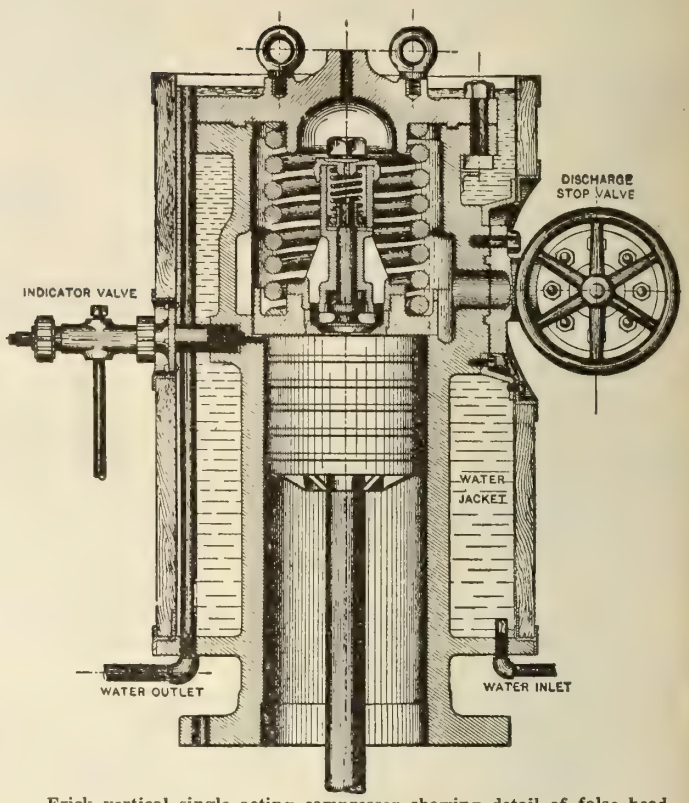
In Fig. 3 is shown a section of a double acting compressor as made by the Linde people. The arrangement of the suction and discharge valves can be seen very clearly, the suction valves being on the bottom and opening inwards, the discharge valves being on the top and opening outwards. The piston is made with hemispherical ends, and the cylinder heads are made to conform to the shape of the piston, so that clearance is kept down to a very small amount. The absence of any water jacket will be noted. This type of compressor works on the wet system, that is, a certain amount of liquid ammonia is injected into the cylinder on each stroke, which is evaporated by the heat of compression, and this absorbs the heat that is otherwise absorbed by the water jacket. The arrangement of the stuffing box and packing are plainly seen.

Figure 4 shows a view of a vertical compressor as made by the De La Vergne people, and this is of the oil sealed type. At the bottom of the cylinder and on top of the piston will be noticed a thin film of oil, and this is used for filling the clearance space at the end of the stroke. This oil also takes up some of the heat of compression, thus fulfilling the same purpose as the water jacket or the liquid ammonia injection. It will be noticed that at the



Single acting York compressor with tank water jacket.

After the gas is compressed, and on its way to the condenser, it passes through an oil separator. An oil separator on a refrigerating machine serves the same purpose that it does on a steam heating plant, which is to intercept oil that would otherwise get through to the system and insulate the coils. If oil gets in the ammonia coils it will cut down their effectiveness very largely, just as it would do if it got in the coils of a heating system, as it is a very poor conductor of heat. The oil separator usually consists of a vertical cylindrical vessel, into which the gas is led from the top, and again taken out at the top. In its passage through the separator it strikes against baffles of various kinds, the result being that any oil which is entrained with the gas, drops down on striking the baffles, and is collected in the bottom of the separator from which it may be drawn off. It is very important that these separators should be carefully looked after, and cleaned out at regular intervals.

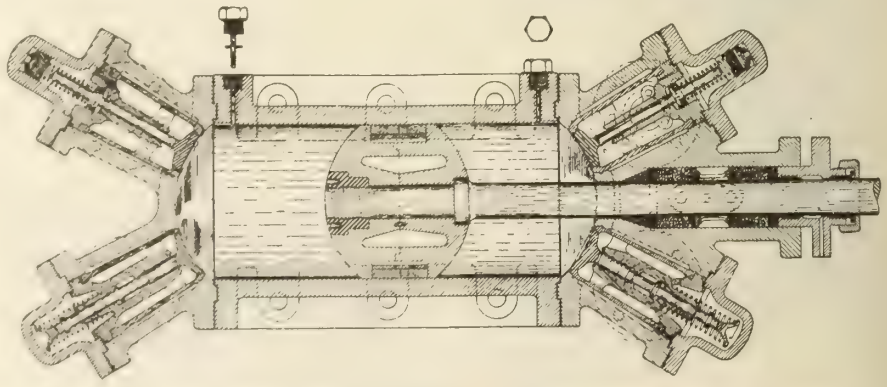


Frick vertical single acting compressor showing detail of false head.

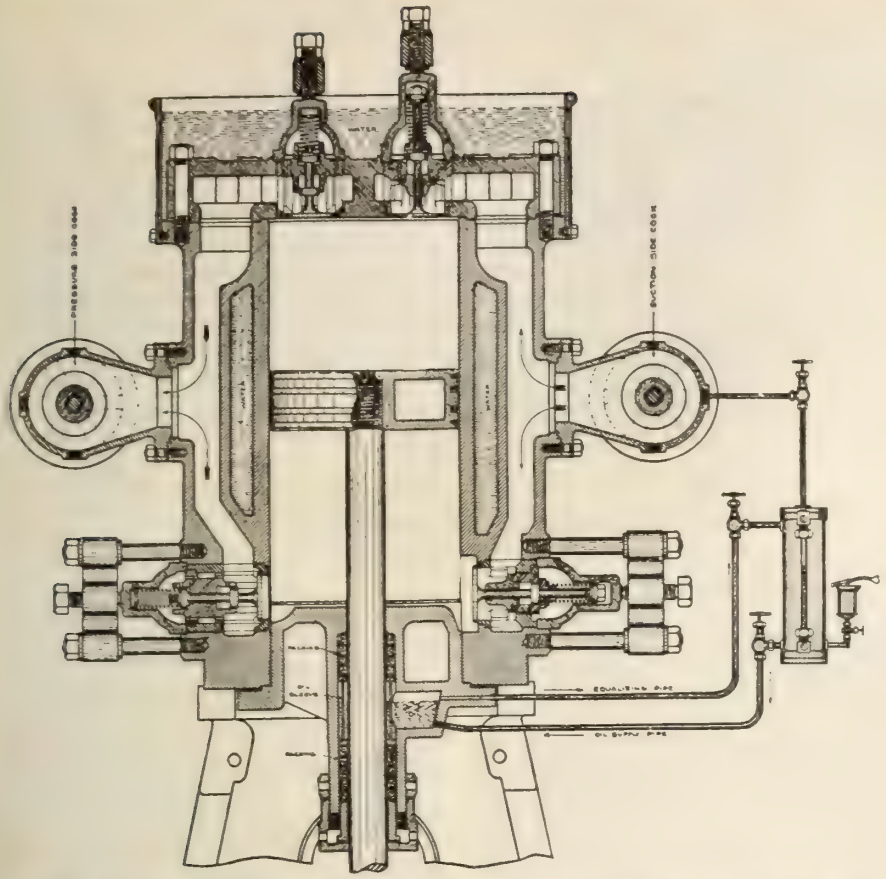
bottom of the cylinder there are two discharge valves one above the other. The idea of this is to minimize the clearance space at the bottom of the cylinder. There are ports in the piston which allow the gas to pass through the piston and out of the upper valve when the lower valve is closed by the piston passing over it. It will be noticed that stress has been laid on the avoidance of unnecessary clearance in the compressor cylinders. This is just as necessary with ammonia gas as with steam, for if there are large clearance spaces, it means that a considerable quantity of gas is required to keep them filled, and this gas must be alternately compressed and expanded with each stroke of the machine. Therefore the less clearance space the better.

Fig. 5 shows a Buffalo compressor of the vertical double acting type, provided with a water jacket. Clearance is kept down by having the valves on the sides of the cylinder, thus allowing the piston to come close to the heads at the bottom of the stroke, while on the top of the cylinder the same condition exists. The general arrangement of valves, water jackets, stuffing boxes and oil supply are well illustrated by this cut.

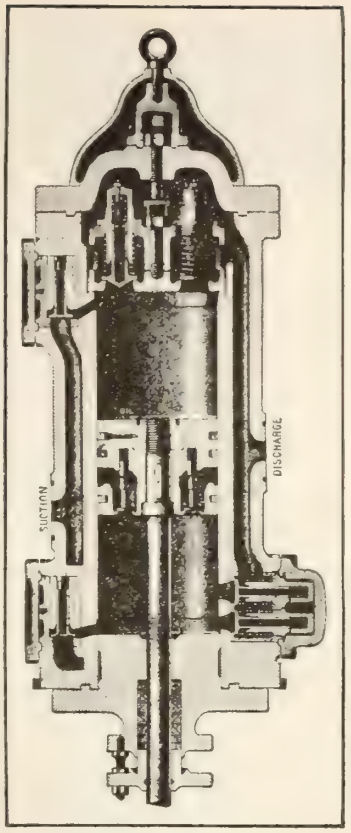
These illustrations show the different general types of ammonia compressors, though there are many makers of machines not among those illustrated. It will be seen that in the design of a compressor the objects sought are minimum of clearance space, adequate means of absorbing the heat of compression, either by water jackets, oil seal, or liquid injection, and accessibility with ample passages in the suction and delivery valves. There is another important point in connection with the suction and delivery valves on compressors, and that is the provision of means to prevent the valves falling into the cylinder in case a stem should break. This has been the cause of several bad accidents in the past, but in most cases at the present time there is a safety arrangement of some kind to prevent this happening.



Linde Horizontal Double Acting Compressor, with Semi-Spherical Piston and Heads Wet Compression.



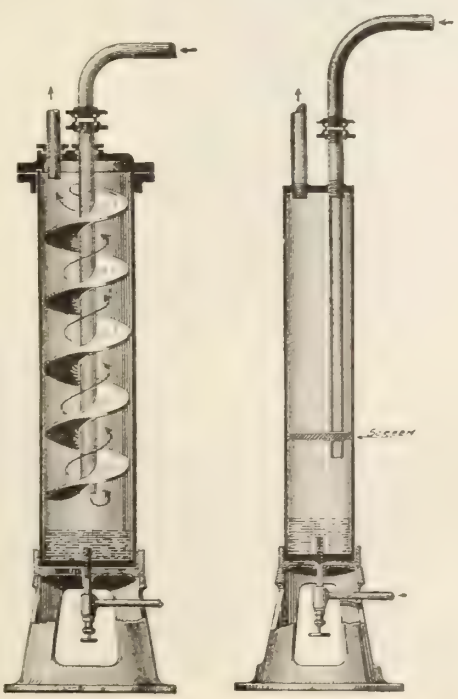
Buffalo Vertical Compressor Water Cooled. The oil well is connected to the suction valve, so that any gas passing into the lantern is drawn into the suction. Note safety collars on valves to prevent them dropping into cylinders.



DeLa Vergne Vertical Compressor with oil seal for filling clearance and double discharge valves on bottom of cylinder.

The Condenser

One of the most important parts of the refrigerating system is the condenser, and there are several types of this apparatus. These are known by names which give a good indication of the differences between them, or rather of the particular characteristics of each. There is the shell condenser, which corresponds in a great degree with the surface condenser known to steam practice, being a shell containing tubes through which circulates the water for cooling or the gas to be cooled as the case may be. In the case of ammonia it is usually the water outside the coils and the ammonia inside, the reason of course being that the ammonia is at a comparatively high pressure, and it is much easier to confine it in the coil than to build a tank strong enough to contain the pressure. The tank may be either round or square, and the coil may be spiral or flat. This type of condenser is usually known as a submerged condenser, and the gas usually enters at the top, the liquid being drained off at the bottom, while the condensing water enters at the bottom, and overflows at the top. This is the best way of effecting a transfer of heat, and is adopted in all cases where such transference has to be made, and is known as the counter current principle. Thus the cold water entering the bottom of the condenser encounters the liquid which has a temperature of perhaps only 10 or 15 degrees higher than the water. As the water travels upwards, it is constantly absorbing heat, and its temperature is being raised. When it reaches the top, it is in contact with the hot gas coming from the compressor, so that, although the temperature of the circulating water has been increased in its passage through the condenser the gas it is in contact with at the end of its journey is still at a considerably higher temperature than the water. This enables a considerable transfer of heat to take place all through the condenser.

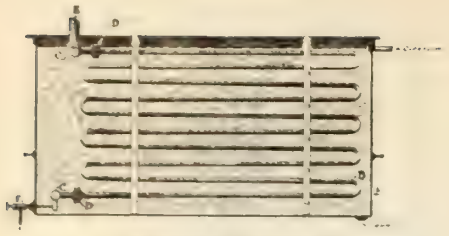


Types of oil separators.

The Atmospheric Condenser

This submerged condenser is a bulky arrangement, and a heavy one, and is not much favored on that account. The atmospheric condenser is probably the most important, and the most generally used of all the types. It is usually situated on the roof of the building, and consists of a series of coils, laid horizontally, and in stands about twelve pipes high. Over the top of each stand is a trough, which is supplied by the cooling water connection, and allows the water to trickle down over the pipes. Owing to the fact that the condenser is exposed to the air, the amount of cooling water required is considerably less than with the submerged type. The circulation of the air among the tubes or coils carries a certain amount of heat away, and the absorption of the water by the air coming into contact with it also requires heat which is furnished by the ammonia in the coils. A certain amount of water is evaporated which also requires heat, which is taken from the coils, so that the latent heat of the water is utilized to a certain extent in absorbing heat, lessening the amount to be dealt with by actual convection.

The gas is introduced at the top in some cases, but this is not so efficient, as the flow of the water and the gas are in the same direction. The gas can be introduced at the bottom of the stand of coils, and pass upwards, drain pipes being provided here and there on the coils



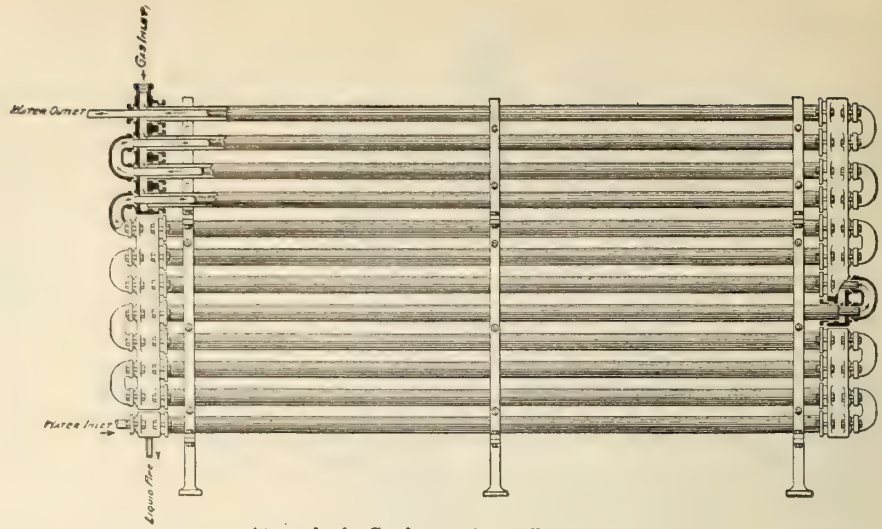
Submerged Condenser.

to collect the liquid as it is condensed, and draw it to the liquid receiver. This is probably the most efficient form as it employs the counter current flow just described. When the gas and water flow in the same direction, we have the hottest gas being in contact with the coldest water. The temperature of the water is therefore increased very rapidly at the beginning of its flow, and as it progresses its temperature is getting nearer the temperature of the gas, lessening the efficiency of the heat transfer. It is of course just the opposite effect to that of the counterflow principle.

The Double Pipe Condenser

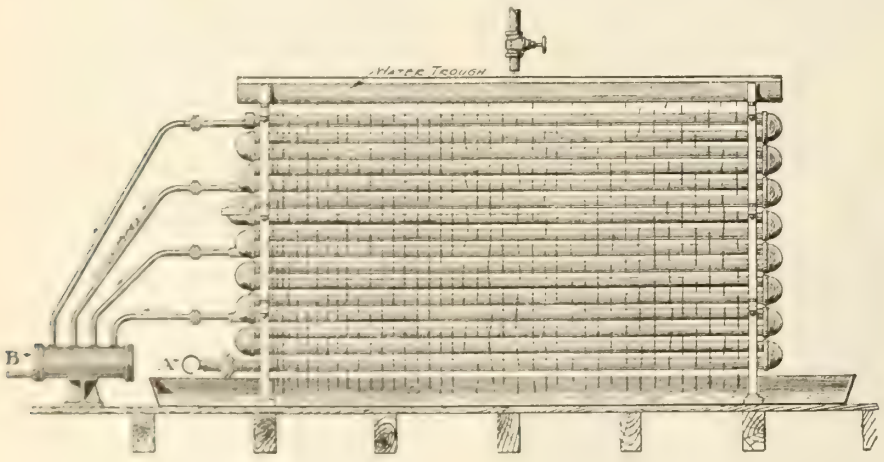
In the double pipe condenser another principle is introduced. In this case one pipe is placed inside another, leaving an annular space between the ou side of one pipe and the inside of the other. The ammonia gas is circulated through the inner pipe, and the water through the outer, or the reverse may be the case, the water being in the inner pipe and the gas in the annular space. The arrangement allows of a very good contact between the gas and the circulating water, as the comparatively small space causes the gas to churn along on its way, thus coming into intimate contact with the pipe walls, and allowing the water to get its most effective work of convection in. The counter current flow can be well utilized in this arrangement, while it is compact and easily accessible for repairs.

The arrangement is easily understood from the illustration, which shows a double pipe condenser the water being in the small pipe and the gas in the annular space surrounding it. The counter current flow is shown.



Atmospheric Condenser Contraflow System.

In the course of opera ion of the system, there is from time to time the unavoidable entrance of foreign matter which is non-condensable such as air which may be drawn into the low pressure side of the system through a leaky joint, and compressed and discharged into the high pressure side. This will affect the efficiency of the machine, and provision has to be made to get rid of such matter. On the top of condenser there is usually a valve or valves, for the purpose of purging or clearing out the foreign gases from the condenser. The method usually adopted is to place a pipe from the valve into a pail of water, and then open the purging valve. As long as there is any gas other than ammonia being discharged, bubbles will rise to the surface of the water in the pail, but as soon as the condenser is clear, and pure ammonia is coming, the bubbles will cease. This is because the water will absorb pure ammonia gas, but will not absorb a mixture of air and ammonia, the air escaping as bubbles. There are thus two places from which objectionable matter can be extracted from the system, one being the oil separator before the condenser is reached, and the next being the purging valve on the top of the condenser.



Atmospheric Condenser.

The Receiver

After the ammonia gas is condensed, it drops down the condenser coils into a tank known as the liquid receiver. This is a tank very similar in construction to the oil separator tank illustrated, and it forms really a reservoir between the condenser and the expansion valve. The liquid enters at the top, and is drawn off at the side of the tank a little distance above the bottom. This allows for any scale or other impurities settling on the bottom of the receiver from whence they can be drawn off, thus avoiding the chance of the expansion valve seats being scored or the valves held off the face through small pieces getting on the seats.

Following the liquid receiver, the next feature we come to is the regulating or expansion valves, and these will be discussed in a later article.

BOOK REVIEW

We have received from the McGraw Hill Book Co., Inc., of New York, a copy of a new publication entitled "Steam Power Plant Auxiliaries and Accessories." The book is edited by Terrell Croft, of the Terrell Croft Engineering Co., himself the author of a number of books on engineering subjects. The present volume is along lines which should appeal very strongly to the power plant engineer. It deals in a very complete manner with the various auxiliaries and accessories to be found in a modern power plant, illustrating each one very fully, and also goes into the economics of the question, showing by calculation just where the advantage or otherwise of certain types of auxiliaries lies.

The first chapter of the book is devoted to pump calculations which are of great interest to every engineer, and these are followed by chapters on direct acting, crank action, and centrifugal pumps, injectors and various feed pump governors, feed water heaters, economisers, separators, steam traps, etc., are all very fully gone into. This is one of the most useful books for the power plant man that we have seen for some time.

The Importance of Emergency Closing Valves

When an Accident Happens to a Steam Turbine Running With High Velocity Steam, the Arrangements for Closing Off the Steam Quickly and Safely Are Very Important—The Method is Described Here

By P. W. KNAUF*

IT HAS for a long time been general practice to install gate valves at the boiler end of steam pipes serving turbine units so that the steam can be cut off when a turbine and its throttle valve are opened up for inspection, cleaning or repair. In order to operate such valves the attendants are obliged to climb to the top of the boilers. For this reason the valves are frequently equipped with motor drive, with control stations in the boiler room and elsewhere.

Motor drive, however, does not convert a large gate valve into an emergency shut-off valve. A gate valve cannot be made to lose instantaneously. In fact, it should only be closed at times when there is no steam flow or opened when the pressures existing on both sides of the gate have been equalized by means of the by-pass customarily provided. Under such balanced conditions, with the usual size motor and gearing, the speed of closing the gate, that is, the rate of travel of the gate spindle is about 1 ft. per min. An 18 or 20 in. valve therefore requires nearly 2 min. to close by electric motor drive.

If for example the attendants are unable to get near the turbine throttle valve, as has happened frequently, or if the throttle valve is for some reason inoperative, when the motor driven gate valve must be depended upon to shut off the steam flow to the turbine, that is, the gate valve must close when the steam flow through it is, depending on the load, anywhere between 5,000 and 13,000 ft. per min.

A far more severe condition is a rupture of the pipe between the header gate valve and the turbine. In such an event the gate valve must be closed instantly in order to prevent the boilers from being blown down. Under these conditions, the gate must be forced perpendicularly through a steam velocity that is many times in excess of full load flow because boiler pressure exists on one side of the gate and an open end or atmosphere on the other.

The effect of closing a gate valve when a high velocity flow is passing through it is that the bottom edges of the gate or discs will be tilted or dragged in the direction of flow as these enter to close the ports. The result is that the gate will be jammed in the body guide-ways, and if not actually stalled, the speed will be greatly retarded and the power required enormously increased. Under the most favorable conditions it is therefore unreasonable to expect the gate to complete the travel from the full open position to the shut position in the same time as under no flow conditions. In case of pipe rupture or turbine trouble time is precious. Instantaneous response to automatic or hand control is vital; to wait two minutes or even one minute under such conditions for a long travel valve to screw itself shut is entirely out of the question, especially when all the conditions are in favor of failure.

An emergency closing valve must under the conditions enumerated close instantaneously but without shock. It must primarily be safe and dependable. The purpose of this article is to describe a new type of cushioned emergency closing trip valve that has recently been developed and installed in some of the large central station, lighting, and electric railway companies.

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The valve, which is of the balanced combined trip and throttle type, is shown in the open position in Fig. 1, and con-

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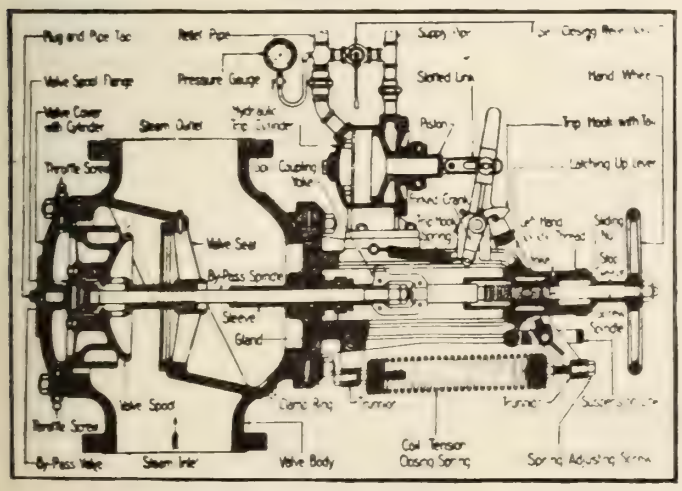


Fig. 1.—Emergency closing valve in open position.

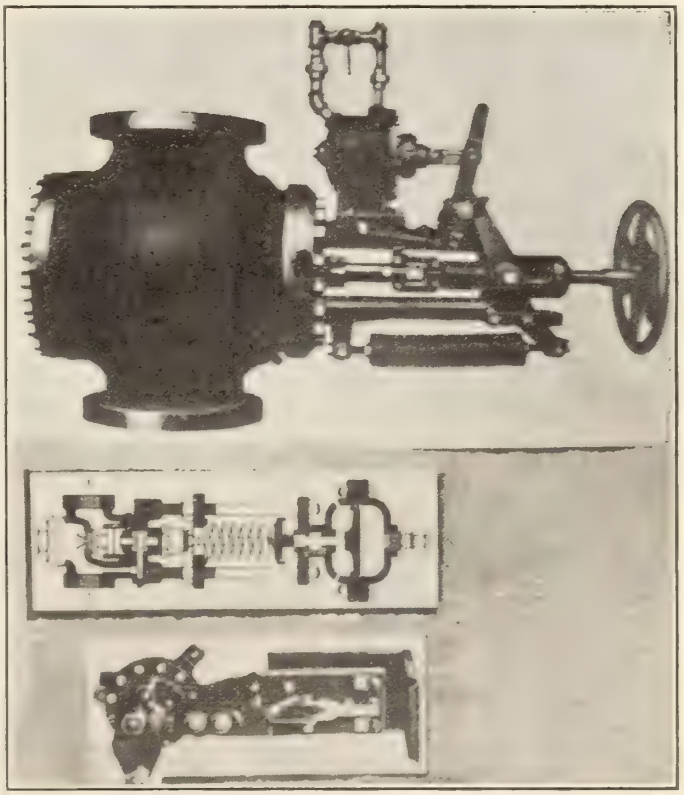


Fig. 2.—Emergency closing valve showing relation of principal parts.

Fig. 4.—Diaphragm controlled valve for actuating emergency closing valve.

Fig. 6.—Diaphragm type pressure regulator.

sis.s of an easy flow, excess are a globe body having disc connected to a non-rotating spindle which, in turn, is suitably connected to a rotating spindle having a spindle thread. This thread engages with a nut that is free to slide in the yoke end or arch. Pivoted about a stationary fulcrum on the yoke is a lever, of which the shorter arm is connected to the yoke by means of a spring, and the longer arm is arranged to engage in a hook controlled by the tripping mechanism. This longer arm of the lever is known as the latching up lever and is connected by means of pivots to the sliding nut mentioned above. The engagement of the latching lever with the trip hook is assisted by two tension springs, one on either side of the yoke. The steam inlet is above the valve seat and the outlet is below the seat—the disc therefore closes in the direction of the steam flow (not against the steam flow) and after having seated is held shut by the steam pressure.

Fig. 2 shows the general relation of the principal parts. The tripping mechanism of the valve shown in Figs. 1 and 2 is actuated by a hydraulic cylinder under 25 to 75 lbs. water pressure. The mechanism can, however, be electrica ly operated on 125 or 250 volts direct current.

The operation of the valve is as follows, see Fig. 1: Assume that a pipe rupture occurred on the outletside of the valve, or that the steam pressure has dropped below the minimum allowable boiler operating pressure. This in turn will cause a diminution of hydraulic pressure in the relief type, thereby causing the piston in hydraulic trip cylinder to be moved to the left. Under these conditions, the latching up lever is disengaged and the unbalanced steam pressure acting on the top of the main valve disc and the non-rotating valve spindle closes the valve instantly. The closing is assisted by the coil tension closing spring.

To open the valve, it is first necessary to turn the hand wheel in a clockwise direction, whereupon the sliding nut is moved toward the valve body and the latching up lever re-engaged with the trip hook. Thereupon turning the hand wheel in a counterclockwise direction forces the disk off its seat and opens the valve.

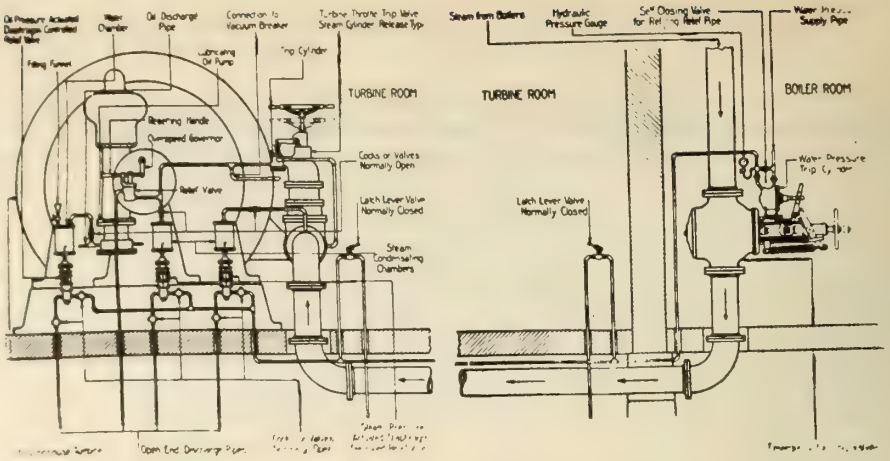


Fig. 3.—Arrangement of Emergency Closing Valve Having Hydraulic Trip Cylinder Release for use on steam mains to large turbine units.

A typical arrangement of the valve having a hydraulic trip cylinder release with four methods of distant control is shown in Fig. 3. The water in the hydraulic trip cylinder and relief pipe is ordinarily under 5 lbs. pressure gauge, and is taken from the city main or from the discharge side of the boiler feed pump. It is introduced into the system through a self-closing valve that is closed as soon as the relief pipe has been filled. There are four methods of distant control divided respectively by a number of latch lever valves in the relief pipe, a diaphragm controlled relief valve operated by steam pressure in the steam pipe serving the turbine, a second such relief valve operated by the overspeed governor, and a third relief valve actuated by the pressure of the lubricating oil.

The latch lever valves are normally closed and are hand operated. Any number of them can be installed. If a latch lever valve is opened, a flow of water occurs in the relief pipe—thereby diminishing the hydraulic pressure to the left of the piston in the trip cylinder, releasing the latching up lever and triping the emergency closing valve.

The diaphragm controlled relief valves are of the type shown in Fig. 4. A diminution in pressure in the chamber above the diaphragm permits the spring to rise and to open the valve, thus permitting a flow of water to occur through the bottom of the valve,

Ordinary cocks are installed on the relief piping on either side of each of the diaphragm controlled relief valves. These cocks are normally open. When the overspeed governor of the turbine is to be tested, when steam pressure is being built up, or oil pressure is being built up, the cock immediately before each diaphragm valve is open, but the other one is closed. These cocks also permit inspection or removal of the diaphragm valves while the turbine is in opertion.

The emergency closing valve is adapted for use with various methods of control in addition to the one described above. Fig. 5 shows an arrangement of the so-called closed circuit direct current type, 125 to 250 volts.

Here an electro-magnet is utilized, the armature of which is a swing weight that, when the circuit through the magnet is broken, drops and trips closing valve shut. Current flows continually through the electro magnet, one or more self-closing push switches, a diaphgram contact breaker (the contacts of whih are normally closed) actuated by the steam pressure, through a second diaphgram contact breaker actuated by the lubricating oil pressure, and finally through a switch on the turbine throttle trip valve. The electro-magnet, push switches, contact breakers, etc., are all connected in series.

The contacts of the switch on the throttle trip valve are normally closed.. They are broken by the tension rod of the overspeed governor when the turbine overspeeds. Under these conditions, not only does the turbine throttle trip valve close, but inasmuch as the switch is opened, the emergency trip valve is also closed.

Here, as in the other arrangement, four methods of distant control are available, of which one or all can be used. Three indicating switches are ordinarily installed for short circuiting the contacts of the diaphragm circuit

(Continued on page 35)

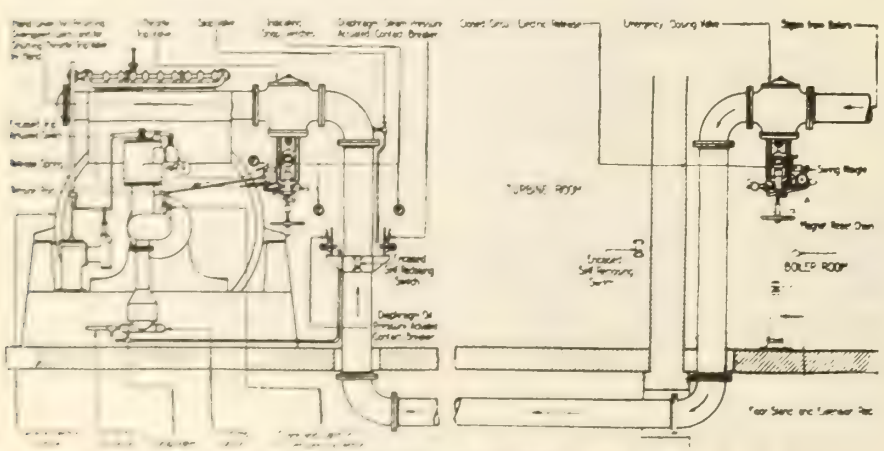


Fig. 5.—Arrangement of Emergency Closing Valve With Closed Circuit D. C. Electric Release Mechanism.

On Coal and Ash Handling Equipment

The Numerous Types of Apparatus for These Purposes Are Described in Outline, and the Suitability of One or the Other is Indicated Under Differing Conditions

By HARRY R. WESTCOTT, of Westcott & Mapes, Inc., New Haven
Read before the Students of Engineering, Yale University

FUEL IS and always has been one of the vital factors behind international politics. The controversy between France and England revolves largely around coal and ore. England is afraid that France is getting too much coal and ore away from Germany. The controversy between Mexico and the United States is largely one concerning fuel, but in this case it is oil.

Fuel, and particularly coal, is a basic commodity which is fundamental to the life of every nation. To-day it stands in the very foreground of our business conditions. Linked with it and equally as important is labor and transportation.

We know that our transportation systems were in 1917 the cause of one of the most perilous coal shortages that we have ever faced. We also know that the present transportation situation has a very unfavorable effect upon the price of coal. What is true now regarding coal, labor and transportation will always be true, so long as there are storms on the sea, cycles of prosperity and adversity, and strife between capital and labor.

It is peculiar that coal, labor and transportation should be so closely related that a disturbance in one, be it economic or otherwise, is accompanied by a like disturbance in the others, the effects of which are so far reaching that it may lead to the expenditure of amounts reaching into the millions for coal handling and coal storage equipment as an economic safeguard, as well as for the purpose of conserving labor and decreasing costs.

The typical coal handling and storage equipment for power station service includes machinery for unloading from barges or cars, crushing, yard storage, reclaiming, conveying to overhead bunker and larry or automatic scales.

The selection of this equipment should be governed by the means of transportation, the amount of coal that is to be unloaded per hour, amount to be stored per hour in yard, total to be stored in yard, hourly reclaiming capacity, bunker capacity, amount to be distributed per hour to boilers, installation cost, cost per ton to handle the coal, flexibility and ability to meet future development.

At this point, I would like to explain that the hourly unloading rate and handling rate as commonly used is incorrect, referring as it does to the average maximum conditions. The correct hourly rate is on the basis of unloading the average maximum shipment in a day's shift or any other given period of time. This, you will observe, includes delay due to moving boats, cars and other causes. This correct hourly rate, which is the effective rate, is frequently 30 per cent less than the maximum rate. On the other hand, the momentary maximum unloading rate should not exceed the capacity of the equipment which takes the coal away.

The proper general arrangement of the system and the correct consolidation of its several units is especially difficult because there is no general agreement as to which type of equipment is best. In other words, the art is not standardized. The various individual units in the coal handling system have made some progress on the road of standardization, but even now in many cases no one can definitely say which particular unit is the best to use under certain conditions.

The individual units have their strong points and their limitations. Mistakes are usually made by trying to use the units to do the things that they are not suited and cannot do efficiently. If less thought were given to the strong points and more to the limitations of the individual units, better coal handling systems would be installed. Instead of that, however, the assumption is usually made that a certain unit will do several things well because it does some one thing particularly well.

In general, the arrangement of the equipment should permit taking coal directly from boat or cars to bunker, without going to yard storage.

In moderate size power houses the storage pile should be alongside of the power house and so intimately and simply linked thereto that the coal in the pile is almost as available as the coal in the overhead bunker. That is, the machinery connecting the coal pile with the overhead bunker should be of the simplest and most dependable type and the distance between the coal pile and the overhead bunker should be a minimum. Where a central coal storage pile of large capacity is required to supply a number of scattered power houses it might not be necessary to install ground storage at the power house. This depends upon the reliability of the transportation medium connecting the central storage and the power houses. Large isolated storage piles for this purpose are not common, therefore, more stress will be laid upon the coal storage for moderate size boiler houses adjacent to the boiler house. The proper type of equipment to employ, however, would not be different no matter where the storage pile is located because the problem of handling coal into and out of the pile is the same.

Yard Storage

It is the opinion of experts that the amount of coal stored at the power station will become greater than heretofore. It is a regrettable fact, but none the less true, that the average consumer is an "11th hour" buyer. The seasonal demand on the coal mines, the transportation systems and the coal dealers, results in all operating under pressure during the seasons of the year when transportation facilities are the poorest; and on the part time during the other seasons when transportation facilities are the best. This is wasteful and is the cause of unemployment, idle freight cars, delays of much consequence and general dissatisfaction. The present modest reduction in the price of coal during the summer months has not been sufficient to cause a greater amount of coal to be stored. Coal provides nearly 25 per cent. of the total tonnage of all American railroads. If the railroads could be induced to allow a low season differential rate, which would be sufficient to cause a greater movement of coal during the off season months, the consumer, dealer, railroad operator and miner would profit. The storage of coal is also encouraged by transportation difficulties, the strike menace, and the desire to prevent excessive prices. The drawback is the cost and the possibility of fires. Notwtihstanding these, however, the storage of coal is on the increase.

Fires are due to coal dust, varieties and sizes of coal store, ventilation and height of pile. It is difficult to control all these conditions except the height and method of piling. Therefore, where space and cost are not too great, the general procedure is to pile the coal not over 20 feet deep, install equipment which can effectively combat the fire and then exercise eternal vigilance. On that basis, fires can be controlled if taken at the beginning. I would point out, however, that coal is frequently piled more than 20 feet deep, especially when very large quantities are stored.

Delays in delivery are usually due to transportation and labor difficulties. The amount of coal to be stored outside depends upon the duration of these difficulties. In any event, sufficient coal should be stored in the yard to permit operating the plant during the cessation of delivery of average duration.

Nothing is more uncertain than the

sea and the weather. Fogs and storms may cause a week's delay, and occasionally a barge is lost. Delays in railroad transportation have proved in recent years to be of longer duration.

It is believed, however, that labor troubles are apt to cause the most serious delay. Strikes, particularly at the mines, are liable to last a number of weeks. It is, therefore, becoming common practice to store sufficient coal to operate at least 90 days. Whether this is too much, or too little, depends more or less on where we are in the general business cycle and the supply and demand for labor.

Receiving Hopper

In the past few years, it has been difficult for the purchaser of coal to control the kind of car in which his coal is shipped. However, coal unloaded from cars in the eastern part of the United States is, in the majority of cases from hopper bottom cars and to a truck or receiving hopper. A bucket may be used for unloading, but it will handle only 90 per cent of the coal in the car without trimming and the bucket and car are frequently damaged.

The hopper should be large. Its size should be determined by the largest coal car in use on the connecting railroad or the largest bucket likely to be used. If cars are used, the hopper should be somewhat longer than the overall lengths of the car pens so as to make spotting of the cars easy. The volume of the hopper should be sufficient to hold the coal as it flows from the car or bucket, with the coal handling equipment running. It takes at least fifteen minutes to get fifty tons of coal out of a hopper bottom car under average good conditions, including placing the car and removing it. This is at the rate of 200 tons per hour maximum in a single track hopper. Unfavorable conditions, such as long hauls, wet coal, frozen coal, inconvenient type of bottom dump car, may reduce this to 100 tons per hour. The hopper should be of sufficient size to receive all that drops out by gravity when the car doors are opened. This never exceeds one half of the carload, or 25 tons.

The track at the hopper should be on a slight grade to facilitate moving empties by gravity, or a winch will have to be used.

The hopper may be either wood, concrete, or steel plate, but preferably the last and ¼ in. thick, or thicker. The lower 3 in. should be renewable to provide for the rapid wear. Its sides should have a minimum valley slope of 45 degrees and there should be ample room below it for installing reciprocating feeder crusher, and conveyor drive, all of which should be well protected from the weather. This equipment, where possible, should be above the ground where it will be well lighted and accessible so that it can be sure of receiving proper care. Placing this equipment above ground may necessitate the use of a conveyor from the feeder to the crusher. When unloading by buckets it is customary to provide a screen or bar grizzly over the hopper, to exclude the very large lumps. It is inadvisable to use a screen when coal is unloaded from hopper bottom cars because of the obstruction to continuous flow.

Traveling Bridges

Yard storage can be taken care of by a traveling bridge, belt conveyors, cable cars, a cable drag scraper or locomotive cranes.

It is obvious that all possible arrangements of unloading, storing and reclaiming bridges cannot be discussed in a single paper. Their design depends entirely upon local conditions, coal to be handled, arrangement of property, etc. Two bridges are seldom alike. There are, however, a few principles which apply to all.

(a) The horizontal transportation of coal by a bucket is slow and expensive.

(b) A belt conveyor has greater capacity, is light in weight and requires less power per unit delivered.

(c) A bucket is the only assured means for combating a fire.

(d) The operator should have an unobstructed view of all operations.

(e) The equipment should be able to operate regardless of weather conditions and frozen coal, though frozen coal is not important in some sections of the country.

A traveling bridge can be arranged with a cantilever boom for unloading boats. If this boom extends over the harbor line, it must be hinged to swing back when not in use. Coal can be distributed to the yard by the unloading bucket or by means of a distributing belt and tripper. It can be reclaimed by the same bucket. A cable car system may be used instead of the belt system. If several different kinds of coal are used in a steel mill or gas works, the bridge may also be equipped with a reclaiming bucket and belt. This permits putting coal into storage and reclaiming from storage simultaneously. Obviously, this equipment has a very high capacity, perhaps around 400 tons per hour. It is open to the objection, however, of being unable to simultaneously store in one end of the yard and reclaim from the other.

Another device used for unloading from boats and storing is the rotating stiff leg derrick of a super-type. This is an all steel structure, having a horizontal boom about 100 feet long and about 50 feet above the ground. It uses a bucket which hoists and travels horizontally on the boom, meanwhile the entire structure rotates. It will handle 150 tons per hour and store approximately 10,000 tons.

The cable drag conveyor system may receive coal by rail which is discharged to a hopper and then a pile is built up nearby by a bucket elevator. If coal is received by boat, the pile may be built up by the unloading equipment without the use of a bucket elevator. The coal is distributed by a bucket dragged by a cableway. One end of this cableway is fixed at the bucket elevator, but the other end can be moved from post to post around the periphery of the storage space.

The coal is reclaimed by dragging it back to another hopper at the foot of the bucket elevator. This elevator then raises the coal to a conveyor which takes it to the boiler room. It is obvious that reclaiming is just as efficient and economical as "stocking out."

The first cost of such a system is comparatively low and the "overhead" chargeable to operation is also low.

This system has the advantage of storing coal at a uniform depth over an area of any shape. It does not separate the lumps from the fines, thereby decreasing the likelihood of spontaneous combustion.

It stores at the rate of 100 tons per hour and is suitable for large as well as small capacities where the storage is purely reserve and not active. Sleet and frozen coal are against it and it handles fires with only partial success.

The cable railway is a "half" system which, with one exception, is most effective for large capacities or long hauls. It operates successfully on horizontal or incline runs and around horizontal curves.

The system may be either the continuous loop or shuttle type. The shuttle type operates with two or more cars with parallel tracks or a single track with switch.

The cable may run continuously or intermittently and the cars may be permanently or temporarily attached to the cable. The dumping of the cars is entirely automatic.

This is an especially convenient system for weighing coal, which should be done, however, at the loading point.

The cars are of wood, "V" type mounted on two swivel trucks, four wheels each. The cars are side discharge and are opened by a tripper at any desired point. They may be of 2 or 3 tons capacity. Recent installations have cars of 4 tons capacity with automatic grips, automatically changing from the incoming to outgoing cable while the car is in motion and without an attendant. The car doors are likewise closed by an automatic device before reaching the loading point.

This system runs at a speed of from 200-300 feet per minute, with a range in capacity up to 1,200 tons per hour with one attendant. It is simple and rugged and has very low maintenance charges. It has, however, no ability to reclaim, which is a serious drawback. It is, therefore, more suitable for conveying than for reclaiming. It has the advantage of having its supporting structure buried in the coal. This interferes with reclaiming and may be destroyed by fire.

Automatic Railway

The automatic railway is in many cases the most economical, both from the standpoint of initial cost, operating and upkeep for transferring coal from a receiving point to a storage pile. The

cars are from one to two tons capacity and operate by gravity along a trackway which has declivity of 3 or 4 per cent. The car discharges automatically at a pre-determined point. Upon reaching this point, the car picks up a counterweight which brings the car to a gradual stop. The car is returned up the incline by the force of gravity of the counterweight, which has been raised by the momentum of the car. This system will handle up to 200 tons per hour. The maximum length of the runway is 500 feet. Most of the objections applying to the cable railway and the telepher apply to this system, except as just stated.

The locomotive crane is used for medium-sized systems. It can be combined with a bell system having tripper and short distribution belts, to good advantage. If a crane is used for unloading from boats, it should have an elevated operating cab so the operator can see into the boat. There should be ample room for the fireman. Short booms are preferable because easier to handle and more stable on the track. Such a crane has a continuous capacity of about 50 tons per hour under good conditions.

The telepher or monorail is not seriously considered because of its unavoidable and fundamental defects. It handles only in a single line and therefore has a low handling and storage capacity, considering its initial cost. It reclaims only about 50 per cent. of the pile without hand trimming. Storing from a fixed point is more apt to cause combustion because the lumps are at the bottom and outside, thereby admitting air. Meanwhile, the fines being above, prevent the escape of heat. A good system will cause no great separation of the sizes.

Before leaving the subject of yard storage, I would like to point out that there are many good systems for storing coal in the yard. Reclaiming is more difficult. Fires have to be combated and the only successful means is a bucket. Buckets cannot reach coal under trestles and other elevated structures without excessive and costly hand trimming. This tends to eliminate several of the systems just described and narrows the field down to a system which can efficiently use a bucket for reclaiming as well as storing.

Feeders

A reciprocating feeder should be used for feeding coal from the receiving hopper evenly and continuously to the crusher. This is particularly necessary if run-of-mine coal is received. The feeder should be driven from the crusher to insure simultaneous starting. A better arrangement is to start the crusher first and when it is up to speed, start the feeder by means of special electrical interconnections arranged so the feeder must be stopped first.

If unlimited headroom under the track makes it necessary to elevate the coal between the hopper and the crusher, a belt conveyor or apron feeder should be used in place of the reciprocating feeder. The belt conveyor is generally considered to be dependable and a magnetic pulley may be used with it for removing stray iron. On the other hand, it must be used with caution where large lumps are handled. The reciprocating feeder consists of overlapping steel slats riveted to two strands of steel roller chain which travels slowly on a track.

Crushers

If a large amount of coal is handled, the fines may be by-passed around the crusher thus preventing further breakage and dusting of the fines.

The crusher should be of the two-roll type. The rolls should be of a large diameter (at least 30 in.) to "bite" large lumps of coal. The crusher should be motor driven by means of a belt which will slip off in case large foreign substances enter the crusher. In addition to that, one of the rolls should be provided with relieving springs to prevent breaking the crusher. It should be adjustable if different sizes of crushed coal are required. A flywheel should be provided to even out the power demands. Recently, crushers have been installed in duplicate on sliding bases so that if one crusher breaks down, another can be put into its place. Where there is ample handling capacity and a good reserve of crushed coal, we can see no reason for this.

Belt Conveyors

Where possible, belt conveyors should be used. They are economical of power, dependable, reasonable in first cost and low in maintenance. The speed of a conveying belt depends largely upon the character of the materials handled. As the size of the lump increases, the speed should decrease. The principal difficulty is in feeding the material to the belt so the material will hit the belt the same speed as the belt is moving and the stay on the belt. In other words, keep the belt full. For ordinary crushed coal, belt capacity should be based on a speed per minute for horizontal belts, of not over 250 feet for 12 in. and 400 feet for 42 in. and 20 per cent. less for incline belts. These are conservative speeds which some might take exception to, but it is the writer's opinion that this is a point where conservatism is warranted.

If inclined belts are used, the maximum declivity should not be over 18 degrees because wet or frosty coal will slide on a greater slope. Where space permits, inclined belts are better for elevating coal than bucket elevators, providing the incline belt efficiently fits into the general arrangement of the system. If it does not, the skip hoist is the preferable means for elevating. In other words, the belt conveyor is first a conveyor and only rarely an efficient elevator. All inclined conveyors and bucket elevators also should be equipped with anti-reversing device.

Belts should be of ample width to prevent spilling and if coal containing large lumps is handled, wider belts should be used. A narrow belt to trough properly, must have less plies than a wide one and yet there must be sufficient plies to provide the requisite strength. On the other hand, a wide belt must have plies enough to sustain the load between idlers without buckling, but not so many plies as to trough poorly, even when empty. A short belt carrying the same hourly tonnage will require less plies than a longer one. In any event, it is well to err on the side of too much strength and using rubber at least ⅛ in. thick on carrying side.

Troughing idlers should be not over 4 ft. apart and nearer at loading point, but never directly under the loading point. Return idlers should be about 10 ft. apart. The wider the belt, the nearer the idlers should be. Ball or roller bearing idlers should be used only where power is expensive and then on the basis that the cost of the power saved warrants the extra cost of the ball bearing idlers.

Drives should be at the delivery end of conveyors where possible, particularly on incline conveyors, and tandem drives should be used for heavy loads, especially on incline conveyors.

Adjustable takeups should be used at receiving ends of short belts for tightening same. There should be a weighted idler or gravity takeup, which provides automatic adjustment on long belts.

There should be a continuous decking between the upper and lower sides of belt to prevent coal from falling from the upper side to the lower, or return side and then running between the belt and its pulleys.

There should be a revolving brush at delivery end of all belt conveyors to prevent coal from getting between belt and return idlers. Pulleys should be large, at least five times the number of plies in the belt, so as to eliminate excessive bending of belts and in occasional cases, it is necessary to provide rubber covering to get the necessary friction between belt and pulley.

The drive should be through reduction gears running in oil in a compact, cast iron housing. This should be mounted on a common cast iron base with the motor with flexible couplings on both sides of the reduction gear.

Bucket and Chain Elevators and Conveyors

Bucket and chain elevators and conveyors are of the following five general types, which are arranged in accordance with their merits:

(a) Flight conveyors, which consist of flights at intervals on a single or double strand of chain, with or without rollers. They drag or scrape the coal in a trough and in a horizontal direction only. They will operate on inclines up to 45 degrees at decreased capacities. They are not suitable for handling ashes. Generally speaking, they should be used only in installations where the coal travels 200 ft. or less, or for capacities of 100 tons per hour or less, or temporary systems, though they are widely used in the anthracite collieries.

They are low in first cost, but consume considerable power.

(b) The centrifugal type which elevates only, consists of buckets at intervals on a single or double strand of chain. The buckets fill by digging into the coal in the bottom boot. This is trying work. The discharge at the top is by centrifugal action. It is, therefore, evident that the equipment must run at a considerable speed to dump clear of the top of the elevator. The same type of elevator may have the buckets fastened on a rubber or canvas belt instead of chains. It proves to be a satisfactory arrangement for light, non-abrasive materials having small lumps such as finely crushed coal. Frequently, idlers are placed just below the pulleys at the discharge end for the purpose of completely inverting the buckets when discharging. This is called the "Positive Discharge."

This equipment has an economical capacity of about 35 tons per hour. Its chain speed depends upon the size of the discharge sprocket, as its discharge depends upon centrifugal force. With an 18 in. sprocket the chain speed should be about 175 ft. per min.; 36 in. sprocket, 300 ft. per min.

(c) The "V" bucket, which carries coal when elevating and scrapes it along in a trough when transporting it horizontally. This has V shaped buckets rigidly attached to one or two strands of roller chain. It is obvious that this type of conveyor will not handle anything as abrasive as ashes.

This type has an economical capacity of about 80 tons per hour, and a maximum speed of 100 ft. per min. This conveyor is less expensive to install than the pivoted bucket type, but costs more to operate.

(d) The continuous bucket type which consists of buckets secured usually between two strands of roller chain, or on a belt. The lower edge of each bucket overlaps the upper edge of the bucket below. This arrangement requires the buckets to be filled from a loading chute thereby relieving the equipment from the strain of digging into the coal in a bottom boot. This arrangement also causes the buckets to dump cleanly at a lower speed.

The continuous bucket type is used only for elevating and on nearly vertical inclines.

As the strains of loading are relieved, the carrying capacity is greater and the permissible speed lower, the wear and tear is reduced and the outfit has a longer life than the types previously described when handling equal tonnage.

The maximum speed is not over 150 ft. per minute and it has an economical capacity up to 75 tons per hour.

At this low speed it is evident that the breakage of the coal will be slight. On the other hand, it is sometimes difficult to get a continuous bucket elevator to dump cleanly if the coal is wet, which is often the case. It is suitable for uncrushed coal.

(e) For important work, when the belt conveyor cannot be used, the pivoted bucket machine, which both elevates and conveys through any path, without transferring the coal from one conveyor to another, should be used. This equipment has a capacity up to 200 tons per hour at a speed not exceeding 60 ft. per minute. This is the double strand type with long pitch malleable iron or steel links, having two bars per link. All rotating points are bushed and the chain carried on rolls. The buckets should be either open-hearth steel or malleable iron and designed so the buckets can be easily removed from the chains. The buckets overlap at edge when the chain is in a horizontal position. Malleable iron buckets are better than steel because they better resist the corrosive action of wet coal and ashes. The equipment should include a filler which will not overload or spill the coal or steel shirt boards may be used, stationary and revolving curves or corners, movable dumper or tripper adjustable takeup at lower end and driver. This system was at one time installed quite considerably for handling ashes. Its field is, however, now being restricted to coal.

While this is the most expensive conveyor to install, it is the least expensive to operate, as it takes less power and has the lowest maintenance charges.

All elevators should be encased with steel plate, be self-supporting and bolted together with provision for inspecting and making repairs.

All outdoor belts and bucket conveyors should be enclosed to protect them against snow, sleet and rain.

The wearing surfaces in chutes and hoppers should be at least ¼ in. thick and easily renewable. All chutes should be 45 deg. or more. All rivet heads in contact with coal should be countersunk.

Sharp angles should be avoided and a streamline effect obtained where practical. All gears and belts should have guards. Towers, trestles and other supports should be steel, not wood, and very rigid. Ample space and provision should be made for cleaning, repairing and inspecting the entire equipment.

If designers of coal handling equipment would give more careful thought to these particular matters, which are really very simple ones, there would be far less trouble with coal handling equipment.

The speeds and capacities of conveyors, previously mentioned, are moderate. It is probable that they can be increased 10 or 15 per cent. on very large sizes or on all sizes where the equipment will run but a few hours per day, or where the equipment will receive care and supervision of a high order. Generally speaking, however, for ordinary and average conditions, it is well to be conservative in this particular.

At this point, I would like to again point out that this paper deals principally with coal handling equipment for power stations in the eastern part of the United States. Equipment for special purposes, such as mining, locomotive coaling stations, anthracite handling, and many other varied purposes, may be different, as may equipment used in more distant parts of the world where customs and coals are different.

Skip Hoists

Skip hoists may be used for elevating coal or ashes, and they are exceptionally reliable. Skips are not widely used, however, for elevating coal except in mines, because the skip is intermittent in its operation while the delivery of coal to it is likely to be continuous. If a skip is used, it should in most cases be provided with an automatic loader which takes the coal from the track hopper and fills the skip bucket without overloading, underloading or spilling.

Skip hoists are especially applicable to high lifts, which is where bucket elevators are least desirable.

The skip hoist may be either balanced, counter-weighted or non-counter-weighted. The purpose of balancing and counter-weighting is to save power. It is, therefore, evident that balancing and counterweighting should not be resorted to for small capacities and where power is cheap.

The balanced skip consists of two buckets interconnected so that one bucket goes up as the other comes down. While these are less expensive because of non-duplication of parts, they are a somewhat inflexible arrangement and should not be used unless one is sure that the cycle fits the operating conditions.

Skips may be also of the differential drum type which is an arrangement whereby a drum of varying diameter runs continuously and at a constant speed throughout a complete cycle of loading, elevating, dumping and lowering. While this simplifies the control, it usually results in a more expensive skip.

Skips may be used with either vertical or incline track or a combination of both, depending upon the requirements.

Counterweights are frequently omitted with skips having inclined tracks because of the complications involved. If counterweights are used, their track is frequently vertical, while the skip track is inclined.

Except in very special cases, the maximum hoisting speed should be about 250 in. per minute, where the distance hoisted is 100 in. or more, and the hoist distance must not exceed 150 in. per minute if an automatic loader is used because of the shock to the loader, unless a control is used which slows down the speed at both the top and bottom of the hoist.

Whether or not the hoist should have automatic control is debatable. We feel that it should not in the average plant. We believe ascent should be accomplished by hand operation of drum type controller and descent the same way. Perhaps in very large plants, having competent mechanics available, automatic control will prove satisfac-

tory. Travel should be limited by limit switch on hoisting machine and another at the end of the bucket travel. Controller should be located at loading point. An emergency push button for stopping the bucket travel should be located at the hoisting machine and at the point of discharge. This push button should be of such type that the hoist cannot be started except by the controller.

As the motor starts under full load, it should have a high starting torque, usually around 300 per cent.

Skip hoists should be located inside of building whenever possible. No employee should be asked to do part of his work inside the boiler room and part outside, because of the extreme temperature range in the winter. The hoistway should be totally enclosed because of dirt and decreased liability of human injury.

Workmanship and materials, especially of the hoisting machine, should be of fine quality. Gears should be totally enclosed and run in oil. All bearings should be bronzed bushed.

Outdoor skip hoists are likely to be a source of trouble because the pits fill with water and freeze, causing motors to burn out. This objection can be minimized, though not eliminated, by extending the walls of the pit above the ground. Sleet, snow and ice cause trouble on guides and sheaves.

As little equipment as possible should be placed above bunkers, limiting it to sheaves and bearings because if it is not easily accessible, it will receive little care and no supervision.

Before leaving the subject of skip hoists. I would like to point out that a cable is more reliable than a chain and that none of the moving parts of a skip hoist are in direct contact with the materials handled.

Weightometer

Except for checking weigh larry or automatic boiler scale records, the value of weighing incoming coal is questionable. All coal is weighed as loaded on boat or cars on government tested scales and under government supervision. This weighing is a reliable function. Practically the only chance for error is in coal lost or stolen in transit. Short weights, if found, are difficult to obtain redress for.

Weightometers may be used on either horizontal or inclined belts, but they must be kept away from trippers which lift the belt and from chutes which may affect them by impact.

Tripper

A tripper will be required with the belt conveyor over bunker to discharge the coal to the bunker unless a shuttle belt is used.

On small installations, the tripper may be hand-propelled but in most cases, the tripper should be self-propelled, automatic and reversing taking its power from the belt. It should be arranged so it will travel back and forth between two selected points or so the propelling device can be disengaged and the tripper discharge in one place only. It should be provided with an automatic brush for cleaning the carrying side of belt before passing over return pulley and idlers.

Bunker Gates

These should be cast iron, duplex type operated by an extension shaft, levers and galvanized chains running over pulleys. If the chains extend within reach of the floor, or if a larry is used, means should be adopted for preventing the chains from hanging in the center of the firing aisle and interfering with larry chutes. Gates 16 in. square or larger shoulder lever operated on both sides.

In selecting the size of the gate, consideration should be given to depth of coal over gate, impact on larry due to falling coal, and particularly to the time required to fill the larry, and the size of the coal.

If larries are used, the gates should be interlocked, either mechanically or electrically, so that a gate cannot be opened except a larry is directly below it and then it should be impossible to move the larry until the gate is closed.

Larries Versus Individual Automatic Scales

The larry permits taking coal from any part of the bunker and delivering to any stoker. The larry permits closer spacing of the gate in the bunker and eliminates dead coal which causes fires. The larry also distributes coal properly to the stoker hopper. Lumps, frozen coal and wet coal clog up the chutes and adhere to hoppers of automatic scales. Automatic scales prevent reaching similar coal which sometimes refuses to flow from the bunker. The automatic scales with overhead mechanism, supports, etc., make the firing aisle dark. The scale chutes have to be removed when cleaining boilers.

While the automatic scale is surprisingly free from trouble, it is only so by constant care. In a large plant where many scales would be used, it is probable that as much of an operator's time would be required to care for the scales as would be required to run a larry. As regards records, it is questionable if this refinement at each boiler is warranted when there are other more convenient methods of getting sufficient records of the day's output. I refer to boiler feed or steam flow meters.

Considering first cost, care and maintenance of many small parts, electrical connections, shafting, supports, etc., and the points previously mentioned, preference seems to be for the larry.

Larry

The hand-operated larry is inadvisable in all but the smallest plants.

The larry should be hand-operated, however, as well as electrically operated to provide for failure of current. A braking mechanism should be included. The larry should hold at least as much coal as the stoker hopper with its extension and as much more as possible. The tendency is to make motor-operated larries larger than heretofore.

The larry should, in all but the very largest sizes, have a circular or elliptical hopper with conical bottom and round, easy flow chute. The chute should never be more than 30 degrees from a vertical and its diameter increase ⅛ per foot in the direction of flow. The top of hopper should be designed to check the flow of coal or spilling in case a bunker gate refuses to close. With small size larries, the operator walks, but if the capacity is three tons or more, it is better to have the operator ride with the larry in an elevated cab so as to permit him to see inside of the extension stoker hoppers when filling them. The operator should not, however, ride so close to the bunker as to be in a hot atmosphere.

It should have a beam type device for registering the weight of each load on a card. The scales, but not the hopper, should have 25-50 per cent. overload capacity. It should dump clean so as to prevent weighing any of the coal twice.

Starting and stopping imposes a severe shock on the larry, particularly the knife edges. With a bunker continuously along the front of the boilers, the larry should run at a slow speed and never more than 75 ft. per minute, with provisions for a slower speed when filling the stoker hoppers. The controller should be of the reversing drum type with dead man's stop so the larry stops whenever the operator's hand is removed from the controller handle. A light should be provided at the scale beam.

Automatic Scales

Automatic scales should be totally enclosed in glass to protect them from dust. An overhead walk should be provided for reaching the scales, shafting, motor drives, etc. Each scale may be individually driven by motor or one motor may drive a line shaft through a silent chain with a small chain drive to each scale. The last is generally preferable because of cost. With this arrangement, the shaft runs constantly and there is a clutch at each scale. The chute should have a universal joint at top and removable supports near the bottom so the chute may be swung into the aisle in case of a fire in the bunker or in case it is desired to clean the boiler tubes.

If a spreader is used at bottom of chute at stoker hopper, there should be an open space about 3 in. wide along the front of hopper to permit breaking up arches in the hopper.

Handling Ashes

Ashes are gritty and may be hot or wet. They cause excessive wear and disintergration. Hot ashes may cause fires in the bunker. Red hot ashes cause distortion of handling equipment. Large and extremely hard clinkers are produced by stokers. Ashes are much more difficult to handle than coal because of the reasons just mentioned.

Ash Hoppers and Gates

It is the common practice particularly where stokers are used, to use large bottom opening hoppers beneath the

(Continued on Page 42)

Isothermal and Adiabatic Expansion

An Explanation for the Power Plant Engineer, of These Terms, in Simple Language, and With as Much Elimination of Mathematics as is Possible in This Subject

By T. H. FENNER

THERE are two words which frequently occur in discussions on gases under pressure, and which are closely related to the behaviour of steam in a cylinder, which the average engineer is inclined to be shy of. These are the two words mentioned in the title of this article, "adiabatic" and "isothermal," and they have a very formidable sound, but like most things, are not so bad when looked at closely enough.

It is our purpose in this article to explain the meaning of these terms without getting into any deep mathematical expressions, although it will be impossible to avoid mathematics altogether.

Isothermal Expansion

The prefix "iso" indicates equality or sameness, and the word "thermal" means pertaining to heat. The two joined together therefore express an equality or sameness of heat or temperature. Therefore the word is used to indicate the expansion or compression of a gas under the conditions of uniform temperature.

This is again the law of Boyle, which states that under constant temperature the product of the pressure multiplied by the volume of a gas is constant. This may be expressed by the statement that "providing the temperature is kept constant, the pressure of a gas varies inversely as its volume."

It is from this law that we construct the theoretical curve of expansion known as the isothermal curve, or the hyperbolic curve and this curve shows diagrammatically the variations of pressure and volume of a gas expanding or being compressed from a volume 1 and pressure 1 to a volume 2 and pressure 2 at constant temperature. We can express this law in a single formula, such as

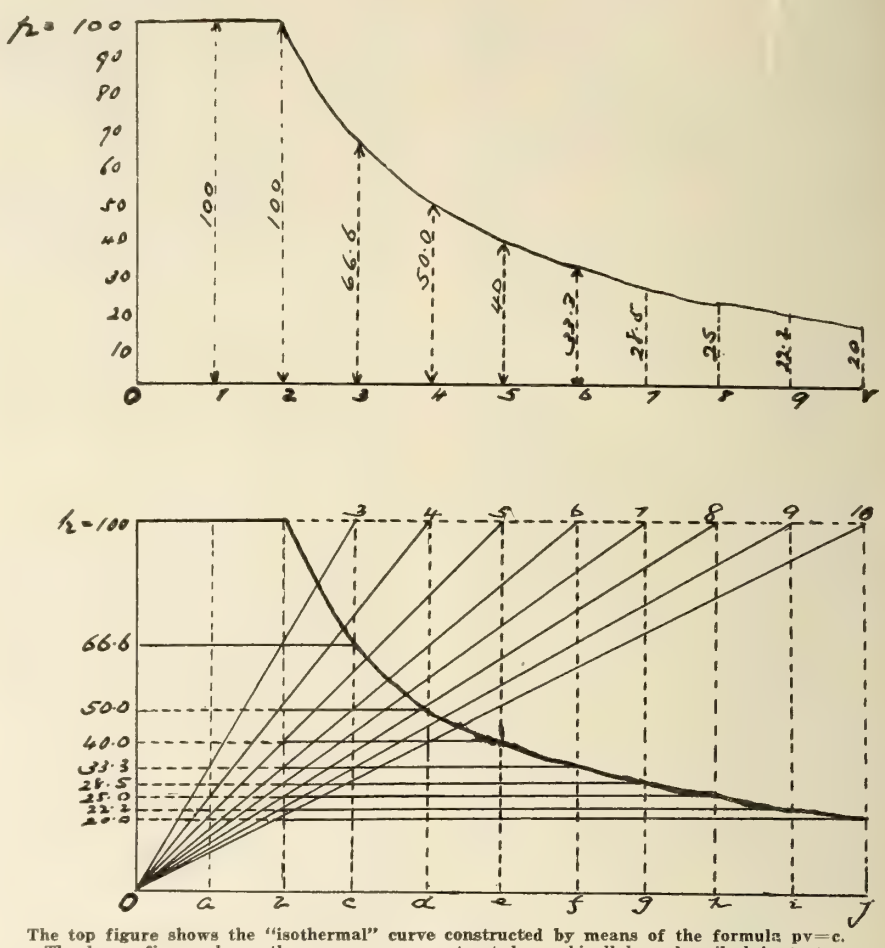
$$pv = p1v1 = p2v2 = c$$

which means that the pressure multiplied by the volume will always give the same result, that is will be a constant.

For example in the illustration we have a pressure represented by 100, and a volume at cut off equal to 2 parts, the final volume being 10 parts. The product of pressure and volume at cut off is 100 x 2 = 200.

At the end of the expansion the pressure is 20, and the volume is 10; 20 x 10 = 200. At any intermediate point we can find the pressure if we know the constant and the volume, or we can find the volume if we know the pressure and the constant.

If p v = 200 when p is 100 and v is 2, then when v is 3 and constant is 200 p will be equal to 200 / 3, or if p is 50 and constant 200, the v will be 200 / 50.



The top figure shows the "isothermal" curve constructed by means of the formula pv=c. The lower figure shows the same curve constructed graphicallyl as described in text.

Thus we have for the total expansion from 2 volumes to 10 the following pressures:

P.	V.	C.
100	x 2 =	200
66.66	x 3 =	200
50	x 4 =	200
40	x 5 =	200
33.33	x 6 =	200
28.57	x 7 =	200
25	x 8 =	200
22.22	x 9 =	200
20	x 10 =	200

We can construct the curve from these calculated values, if we take pressure as ordinates, the volume as abscissae in the diagram. Thus if we lay off a line to represent volume, and divide it into 10 equal parts, and at right angles to it a line to represent pressure, measured from zero, not atmosphere, we have the starting points of our curve. Supposing the steam to be admitted till it occupies two volumes or two of the divisions on the volume line, the pressure will remain at 100, and the line will be a straight one. From this point the steam or gas is allowed to expand, and in doing so it will follow the law that as its volume increases its pressure will decrease, and these changes will be in exact proportion. If we take the pressure at the different points that we have calculated, and erect ordinates to represent these pressures, then a line drawn from the commencement of expansion through all these points will describe a curve. The closer together the points are taken the easier it will be to draw the curve, and there is no limit to the number of points that may be used, except the ability to get the line close together.

We may construct this curve in another manner, preferably by the use of squared paper, but by means of a drawing board and set square in any case. Again take the volume as abscissae and the pressure as ordinates and complete the parallelogram. From the divisional points on the base line erect perpendiculars to reach the top line. Then from the point of origin, that is the cutting of pressure and volume lines at O pressure

and volume, draw diagonals joining the division points on the top line with O.

Now from where the diagonal joining line 3 crosses the perpendicular line 2, draw a horizontal line to line 3. This is the last point on curve. From the crossing of line 4 on line 2, draw a horizontal line to line 4, and this will be another point on the curve. Do this to all the diagonals, and then you will find that all the points on the curve, when measured up, will give exactly the same value as when they were found by calculation. It will also be found that area of the parallelogram enclosed by the horizontal and vertical lines at each point will be the same wherever they are taken, thus proving that pressure x volume is always a constant. In the foregoing, we have considered only two quantities, that is pressure and volume, and we have considered that the expansion or compression of the gas has been carried out without either loss or gain of temperature.

Now we will go into this a little further, to make clear, what is meant by "neither loss or gain of temperature."

If a gas is compressed, it means that mechanical work has been performed on it, and this work will appear in the form of gas in the shape of heat, or added temperature. Now in order to fulfill the law of equal increases of pressure for decreases of volume, this added temperature must be dissipated, and the temperature kept uniform from start to finish of the compression. In order to do this, we must assume that the compression takes place in a perfectly conducting vessel, so that the heat of compression is conducted away as fast as it appears.

Now when we expand the gas back to its original volume, the energy necessary must come from the temperature or heat content of the gas itself, and in the ordinary way, would result in a lowering of temperature far below the starting point. In order to keep the gas within the limits of Boyle's law, we must then imagine that temperature is added from an outside source, to keep the gas at the same temperature from the start to the finish of expansion.

Adiabatic Expansion

It is hardly possible to obtain perfect isothermal expansion or compression in the heat engines in use, such as steam engines, or internal combustion engines. In air compression or gas compression such as are used in a refrigerating machine, an approach is made to isothermal compression by reason of the water jacket which absorbs and dissipates a proportion of the heat.

To understand adiabatic expansion we must assume that the expansion or compression takes place in a vessel which is perfectly insulated, and will not admit heat to pass through its walls in either direction from outside to inside, or vice versa. If we have such a condition, we shall then have all the heat of compression retained in the gas and, therefore the work done during compression is stored up in the gas ready to be given out on expansion.

We also have the condition that while the gas is expanding no heat can be added to it from any external source, and therefore all the heat of compression will be absorbed during expansion, so that we should arrive back at the same point from where we started as far as heat content is concerned. However, the curve traced will not be the same as that traced by the isothermal expansion and compression. We have stated that the isothermal curve represents the expansion or compression of a gas at constant temperature. Therefore if the expansion or compression does not take place at constant temperature as is the case in adiabatic expansion, the curve traced cannot be the same in both cases.

A homely illustration of the difference can be found in the ordinary bicycle or motor pump. Take the pump and move it slowly from end to end of its stroke, drawing in a charge of air, and then compress this air slowly by moving the pump back against the resistance of the air. There will be no difference in the temperature of the pump as observed by placing the hand on it. If the pump is worked slowly and deliberately for an indefinite time, there will be little or no increase in the temperature of the pump. This then is isothermal compression, the heat having carried off through the thin walls of the pump and radiated to the outside air. This is all right as long as the pump is worked very slowly.

Let us now work the pump as we would in the ordinary way when pumping up a tire, and we find that very speedily the barrel cylinder gets hot, so hot as to be uncomfortable to the touch. Here it is evident we are generating heat faster than the walls can radiate it to the outside air. We are approaching the condition of compression without loss of heat, though we do not realize it completely, owing to the thin walls of the chamber. We have taken something that is not quite adiabatic and not quite isothermal, but more nearly approaching the isothermal. If it were possible to compress the air absolutely adiabatically, we should probably set fire to the tire before we had it pumped up.

There is a second law dealing with compression or expansion of gases and that is the law of Charles, which states that if a gas is kept at constant volume, then each degree of temperature added to it, will increase its volume by a definite equal amount. Similarly, if a gas is allowed to expand, so as to remain always at the same pressure, then each degree of temperature added will bring an equal addition of volume.

This law is expressed by an equation similar to the equation of Boyle, but in this case taking the temperature into account. This temperature is also the temperature measured from absolute zero, and is the Fahrenheit temperature plus 459.5. or the Centigrade temperature plus 273. The equation is then

$$\frac{PV}{T} = \frac{P1\,P1}{T1} = \frac{P2\,V2}{T2} = R$$

or the quotient of the pressure multiplied by the volume and divided by the absolute temperature is always a constant, and this constant is represented by the letter R so that

$$\frac{PV}{T} = R$$

If we take a pound of air at the pressure of the atmosphere, and a temperature of 32, or 491.5 degrees absolute, we have, putting in figures in the formula

$$\frac{14.7 \times 144 \times 12.36}{491.5} = 53.37 \cdot$$

Then we have directly from this

$$PV = RT$$

or

$$14.7 \times 144 \times 12.36 = 53.37 \times 491.5$$

The increase of pressure per degree when the air is at constant volume, is not quite the same as the increase of volume per degree when the air is at constant pressure. In other words, the quantity of heat required to raise one lb. of air one degree is not the same when the air is kept at constant volume, as it is when the air is allowed to expand but is kept at constant pressure.

Fortunately we know the relations these two specific heats bear to one another. The specific heat of air when at constant volume, is .1685, and at constant pressure .2375. This means that to heat one pound of air one degree at constant pressure requires .2375 B. t. u.

The ratios of the one specific heat to the other is 1.408, and it is from this ratio that the adiabatic curve of expansion or compression is calculated. Thus instead of the P. V. C. of Boyle's law, or the $\frac{PV}{T} = R$ of Charles' law, a combination of the two is arrived at which gives an equation as follows:

$$PV^{1.408} = P1\,V1^{1.408} = P2\,72^{1.408}$$

which is the equation for adiabatic expansion.

The exponent will not be the same for all gases, but it varies slightly for steam, superheated steam, air, etc. The effect of the exponent is to make the curve of adiabatic expansion higher than that of the isothermal.

The relation of these two curves to the curve we get from an air ammonia compressor, or steam engine, can be now indicated. If we are compressing air our endeavor is to carry away the heat of compression as rapidly as possible from the cylinder walls, and if we are compressing ammonia or CO_2 in a refrigerating machine we also wish to carry away the heat of compression. This means then that we wish to have the curve obtained on an actual indicator diagram taken from these compressors approach the isothermal line as closely as possible.

If we are expanding steam in a steam engine cylinder we endeavor to insulate

(Continued on page 42)

Member of the Audit Bureau of Circulations

POWER HOUSE

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Getting It Started

ON THE opposite page will be found a letter from Mr. Henry Wright, of Montreal, giving details of the action he has taken towards realizing the ideal of an uniform certificate throughout Canada. It would seem from this that the Province of Quebec is going to lead the way in this highly important matter, and be the first to take any definite action.

When we raised the question of a Dominion Wide Certificate in these columns it was because we felt, and always have felt, that the present arrangements were unfair, and hard on the engineer who wished to change his location. There were very many of our readers of the same opinion, and therefore, we have reason to hope that Mr. Wright will get active support from the engineers in other provinces.

As far as the engineers themselves are concerned, a scheme under jurisdiction of the various provincial governments, provided it is an uniform and co-operative arrangement, is just as satisfactory as the Dominion arrangement. It may be a little more expensive to carry on, but the revenue remains to the province, which will please the politicians.

We shall watch with great interest the progress of the negotiations between the different provinces, and we hope to see a lively interest taken in this subject by the engineers themselves, who, after all, are the most affected.

The C. A. S. E. Convention

THE ANNUAL convention of the Canadian Association of Stationary Engineers is only a little more than a month distant, and the delegates to the Grand Lodge will be chosen and instructed very soon now.

The C. A. S. E. has been in existence now for a period of thirty-three years, and during that time has some good things to its credit. It has the opportunity, if availed of, to make itself the representative association of the stationary engineer in Canada, which it is not at present. There seems, however, to be a spirit of progressiveness abroad in the Association, that augurs well for its future. The meetings in the various lodges have been dealing with matters that are instructive to the engineer in his daily work, and the educational side of the lodges' activities have been kept well to the fore.

If the association is going to be the force in future that it should be, it is absolutely necessary that it should attract a greater membership. It is also necessary that this membership should take an active part in its affairs. That the membership is such a small one in such a large field is somewhat of a source of wonder, and the fault must lie within the Association, and not without. We are inclined to think that one of the reasons is that the original form has been too strictly adhered to, and that what was possibly the best type of organization thirty odd years ago is not the best for to-day.

For instance, we think, and we advance these suggestions in all humility, that it is a mistake to mix up an engineering society with a secret society. There is no real connection between the two and the result is that a considerable amount of time is spent on ritual that might better be devoted to engineering matters. Most of us are affiliated with some fraternal or similar organization, and such affiliation does not interfere with our ability to become members of a professional or trade society.

Secondly, we believe it would be a good thing for the Association and the individual members thereof if the membership, like the certificate, was graded. That is full membership would only be granted to those men possessing a certain standard of experience and qualifications, those not possessing this standard, to be associate members. Thirdly, we believe that a man does not value what he gets too cheaply, and the financial standing of the Association should be enhanced by the increase of the annual dues, and entrance fee. By this means, it might become possible, in the larger centres at least, to have permanent rooms, instead of a room that is only open twice a month, and these rooms could be used as a sort of club room, and would be available for lectures, entertainments, etc., on any night required.

The Association would thus become more in the line of a professional society, and if conducted along these lines, would be a guarantee of a man's standing just as the larger professional societies are in their field. With the gradual tightening up of the regulations and the possible introduction of the interprovincial or universal certificate, the privilege of being a member of a strong Association would be sought after.

It seems to us that there would be no difficulty in working out the details of such a scheme, and there are enough capable men within the C.A.S.E. at present to form a strong executive.

It might be necessary to get a new charter, but this would not prove a very difficult matter.

Whatever the form takes, we do not doubt that some drastic change will have to be made, because an organization that stands still cannot be a permanent one. The best friends of the C. A. S. E. are not satisfied with its present status, and rightly so.

The coming convention is the place to take up these matters.

A Move For The Universal Certificate

THE RECENT discussion which went on in the columns of this Journal on the advisability or otherwise of having a certificate of uniform value throughout the Dominion, caused a great deal of interest, and has resulted in some action being taken. The majority of those who expressed opinions were favorable to the idea, and Mr. Henry Wright of Montreal, has gone further than merely expressing an opinion. He has taken some active steps towards realising the idea as the following letter from him will show:

The Editor,
Power House.

May I ask you to publish the following for the benefit of all those who are interested in the Dominion-wide Certificate, as it has been called during the discussions recently carried on in your columns.

I would point out in the first place, that "Dominion-wide Certificate" is not the correct name, and if the scheme should go through, the certificates will not be known in that way. The name will have to be "Inter-Provincial" rather than "Dominion," because the provincial Governments will not submit to what they might look on as interference from the Federal Government in their domestic affairs. The engineers' license from their point of view is simply a matter of dollars and cents, and they will look askance at any scheme that threatens to remove a source of revenue from the provincial treasury.

I have had an interview with the Minister of Labor for the Province of Quebec, who is greatly interested in the Inter-Provincial Boiler and Engineer's laws, as they will be known in future, and he gave me to understand that any interference from Ottawa would be met with disapproval, and that the majority of the Ministers were of the same mind.

He was going to meet the Minister of Labor for Ontario and talk the matter over, and said he would see me on his return. To make doubly sure of this, I am trying to get the Canadian Manufacturers' Association to give the engineers their able support, which I think they will do.

A brief outline of the scheme as I gave it to the Minister would perhaps help those who may be working along the same lines in Western Canada. I would ask every province to have the same standard in their examination and get away from the petty quibbling that one examination is harder than another, and make it all one examination. I do not mean by this that everyone would have to be examined again, but if the Inter-Provincial examination became a fact, the examiners could arrange for the examination for new candidates.

The method of working the law would be as follows: If an engineer wished to leave the Province of Quebec, and take up a position in Ontario, he would apply, either personally or by mail, to the examiner in Quebec, for an identification card. This card would be in triplicate, one copy of which goes to the engineer, the second one is sent to the examiner in the province to which the man is going, and the third one is kept on file in the province in which he was examined. When he reaches Ontario, he notifies the examiner, and produces his identification card, which on being compared with the copy in the Ontario examiner's possession, and being found correct, entitles the holder to a permit of the same grade for as long as he wishes to remain in the province.

If he should wish to return or go to another province at some future time, he will notify the Ontario examiner, and surrender his permit, when the identification card will be again issued to him, and a copy sent to the place he is going to.

The yearly fee will be paid as usual. It will hardly be possible to get away from this, as it is a source of revenue to the province, and under this scheme, the province in which the man is working will get the revenue. Then again, an engineer can be traced from province to province by means of his identification card, and wherever he passes his examination, there his papers remain for reference at any time. He may pass for third in one province, second in another, and first in still another, his identification card from each one proving his eligibility to sit for the higher grade.

I am writing to the Ministers in the other provinces, but at the same time I should like someone in each province to help me in this work which I feel will be appreciated by the engineers in the years to come. I might add that the scheme would make it possible to keep track of a man should he drop out of the game for a few years, and want to steal back to it. His last identity card will give all the information. In the same way, a man could not steal from one province to another, without going through the necessary formalities.

Now, Mr. Editor, the reason I am writing this letter is to let the engineers in other parts know what I am doing, so that they can be aware of the developments as they take place. Any questions which may be asked I shall be pleased to give information on, so that anyone interested can take up the work in any other province.

Thanking you for the space you have given me.

Henry Wright, A.M.I.C.
Chief Engineer,
Montreal Tramways Hochelaga Power Plant.

Editor's Note

The scheme outlined by Mr. Wright seems to be one that will have a good chance of being adopted, and though we would personally rather have seen the whole thing under the Federal Government, we recognize the force of the argument as to Provincial revenues. Provincial governments generally need every cent they can raise, and they are the last ones to dream of cutting off any possible channel of wealth. The proposed arrangement would give as far as we can see a perfectly fair deal to everyone, and should be welcomed by the employer, as it will give him a certain guarantee of the kind of man he is getting, when the man is a stranger in the province. It will save a man the trouble and expense of going up for examination whenever he makes a move, and also ensures that he will not lose the benefit of his years of experience in one province when he moves to another.

Mr. Wright deserves the thanks of his fellow engineers for the time and trouble which he has given to this matter, in their interests, because there is very little probability that he would ever be personally affected by it.

We shall be glad to open the columns of Power House to those who wish to offer suggestions or comment in any way on the subject.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

SETTING OF BOILERS

Question:—Is there any law regulating the setting of horizontal return tube boilers in Ontario? I am told that these boilers should always have a rake towards the back end of ½ inch for every four feet of length. Is this correct, and if so why should it be?

Answer:—The setting of horizontal return tube boilers follows a fairly standard design, the great difference being in the height that the boiler is set above the grates by different designers, or installers. The only regulations are those that refer to the method of suspension, and the minimum width of combustion space, that is distance from back tube plate to back wall. It is usual to set h. r. t. boilers with a slope towards the back end of the boiler, as this is of great assistance when the boiler is being washed out, and when the boiler is working it ensures an ample depth of water above the tubes at the back end when the water in the glass is just bobbing in the nut. As the bottom nut of the gauge glass is usually about four inches above the top row of tubes, this would give at least six inches over the tubes at the back end.

SUCTION AND CONDENSER

Question:—In running an ammonia compressor at 200 r. p. m. what advantage if any is there in carrying a low or high discharge temperature, or what should the discharge temperature be at 25 lbs. back pressure and 165 lbs. head pressure with condenser water at 65 degrees?

Answer:—In operating an ammonia compressor the suction pressure and discharge pressure should be as close together as possible, consistent with maintaining the desired temperatures. The refrigerating effect depends on the amount of gas handled per hour, and the temperature it reaches the evaporator at. If the suction pressure is very low, it means that the gas occupies a large volume, and a less weight of gas per stroke can be handled. If the discharge pressure is high, the machine has to do more work in compressing the gas. The temperature corresponding to a pressure of 25 lbs. per square inch on the suction side is 10 degrees, but if this is 25 lbs. absolute the temperature is about minus 5 degrees. The temperature corresponding to 165 lbs., gauge [illegible], while that corresponding to 165 lbs. absolute is about 83 degrees. Assuming that all the heat or nearly all the heat of compression is removed by the circulating water, or the evaporation of the liquid in wet compression, the gas will leave the compressor at a temperature of between 98 and 100 degrees, and if there is sufficient circulating water passing through the condenser the temperature of the liquid reaching the receiever should be about 75 degrees with circulating water entering at 65 degrees.

Assuming that the pressures given are gauge pressures, then the volume of one lb. of ammonia at 25 lbs. gauge is 6.583 cubic feet. The latent heat at the evaporator pressure is 560 B. t. u. and as the temperature of the liquid going to the evaporator is 75 degrees, the liquid will have to give up to the brine 60 degrees before evaporation takes place. Deducting this from the latent heat this leaves 500 B. t. u. per lb. of ammonia circulated as the cooling effect. Then in order to perform one ton of refrigeration per hour, which is equal to 24,000 B. t. u. per hour, there will have to be circulated 48 lbs. ammonia per hour, or .8 lbs. per minute, or 5.26 cubic feet ammonia per minute.

AIR AND STEAM EXPANSION

Question:—In considering the possibility of an air turbine, I have got the idea that it is impossible to use air for this purpose, because air in expanding through a nozzle does not change heat into velocity the same as steam does. Then again I have read that in the liquefaction of air free expansion is used to lower the temperature. What is the explanation of this?

Answer:—The energy contained in one pound of steam is that due to the total heat, or sensible heat plus latent heat, and in the case of steam at atmospheric pressure, this would amount to 1,146 B. t. u. or 1,146 x 778 or 891,558 ft. lbs. In the case of steam at 150 lbs. pressure the total energy due to its heat content would be 1,194 B.t.u. or 928,932 ft. lbs. If steam is allowed to expand freely without doing work its heat content at the end of expansion will be practically the same as at the beginning, the result being that the steam is slightly superheated. Now by far the greater portion of the energy contained in steam is that due to its latent heat, and when it has dropped to atmospheric pressure, the latent heat is more than it was at the higher pressure, although the total heat content will be less. Some heat will have been lost due to radiation, but this is a small amount, and practically the whole of the energy of the steam at 150 lbs. pressure will be available to be turned into velocity at the mouth of the nozzle. It will be seen then that the influence of temperature is far less than that of the latent heat.

When we are dealing with air it is another matter. The total energy of any perfect gas is entirely due to its absolute temperature, or as it is expressed in Charl's law, "Equal increments of temperature give equal increments of volume, at constant pressure, and of pressure at constant volume." That is, its capability of doing work is entirely dependent on its absolute temperature. It possesses no latent heat as in the case of steam. Therefore if we allow air to expand against the pressure of the atmosphere, the energy necessary is obtained from its temperature. In the case of air the energy available per round is 52.37 x abs. temperature. Take one pound of air at atmospheric pressure and temperature, its energy is represented by the equation

$$PV = RT$$

where P is absolute pressure per sq. ft. V is volume in cubic feet, and T is absolute temperature, R being the constant for air 53.37, and if atmospheric temperature is 32, the 53.37 x 491.5 gives 26,163 ft. lbs.

Compare this with the energy in one pound of steam at the same pressure.

Now take one pound of air which has been heated at constant volume until the pressure is 165 lbs. absolute. The temperature corresponding to this will be found from

$$\frac{P2}{P1} = \frac{T2}{T1}$$

and

$$\frac{165}{147.5} = \frac{T2}{491.5}$$

Then

$$T_2 = \frac{165 \times 491.5}{14.7}$$

$$= 5504.8$$

and the available energy at that pressure and temperature would be 53.37 x 5504.8 = 293801.396.

The work done in expanding freely

from the pressure of 165 lbs. abs. to 14.7 abs. is p $(v_2 - v_1)$
where p is the main pressure during expansion. As the ratio of expansion is $\frac{165}{14.7} = 11.2$ the main effective pressure would be approximately 49.5. The initial volume would be $\frac{12.36}{11.2} = 1.1$ and then we should have 49.5 x 144 as the P and 12.36 — 1.1 = 11.26 as V and work done
49.5 x 144 x 11.26 = 79135.

This amount of work would be performed at the expense of the temperature in the gas. However, when we have expanded down to atmospheric pressure it is obvious we can make no further use of the temperature energy of the gas, as we cannot expand below atmospheric pressure, as in the case of the turbine.

It is therefore obvious that the use of air as a working medium in a turbine is hardly practicable.

The equations above are of course only approximate. Air under compression follows the law PV = C, and in the figures we have not taken the exponent into account.

AN APPRECIATIVE SUBSCRIBER

It is not often we allow our native modesty to be overcome, but we feel that in the light of the expressed wish of our correspondent to publish his letter, we have a good excuse to get in the limelight. The letter follows:

Chilliwack, B. C.,
April 28, 1922.

Editor, Power House,
Dear Sir:

I received your letter yesterday and I must say I was very surprised, though highly pleased, to think what an interest both you and the Power House take in the engineer and his vocation. I have been a reader of the journal now for more than three years, and I may say that the Power House has become indispensable to me.

On the evening of its arrival every other piece of literature is put away until the contents are fully digested and salted down to be used on the job as soon as possible.

The parts of the paper that I am most interested in are the descriptions of new equipment and also descriptions of large plants in the East. I thought a great deal of the article describing Mr. Henry Wright's plant at Hochelaga. I think that these articles are very good, as it tends to bring the engineers together and also lets the Western men see how it is done in the East. I would like very much to meet Mr. Wright and men of his stamp, as I know they would prove very interesting to the young engineer and I think there is no better way of getting acquainted with these gentlemen than through the pages of the Power House. "The Question Box" is also very highly thought of by me and also the power plant kinks are very useful. But what comes first and foremost with me is the description of accidents such as boiler and fly wheel failures, water hammer, etc. These things are happening every day, and although how careful a man may be they will happen to the best, so I think no matter how small these things are they should be published and then they could be guarded against.

Your correspondence department always gives me great pleasure and I enjoyed the Dominion-wide certificate discussion and I am very glad to see that the majority were for it, as it tends to help the engineer a whole lot.

You mentioned advertising. I have heard several men say that you carried too much, but that is wrong. If every engineer would take advantage of the descriptive literature that these firms have to offer they would benefit greatly by it. I have sent for literature on various things such as meters, draft gauges, traps, packing, etc. It was not very long before I could put that information to good use, so I think that any man that downs advertising is making a very grave mistake as there is a lot of free information there for the asking and it is every engineer's duty to follow it up because he may never know when he may be called upon to use it.

Taking your journal on the whole I am highly satisfied with it and I think it is 100% efficient and the engineer of today is needing just such a paper. Engineering is a fine trade for a young man who takes it, and is willing to forge ahead. It holds some wonderful possibilities. But it is a very poor one for the man who only wants to know enough to get by on as every engineer knows that no man has to put up with more and works harder than the engineer of a "hay wire" power plant, and that is the place where these men will find themselves as the modern power plant only wants the man who is willing to take an interest and get ahead, so I think it is the duty of every Canadian engineer to subscribe to the only Canadian engineering journal in Canada, and boost it to the limit.

Hoping you will find room to publish this letter in your paper, as I should like some of the engineers to see that we are satisfied with the Power House in the West. Thanking you for the trouble you took in writing me, and wishing the Power House a fine future and every success, I remain

Yours fraternally,
John P. Kingscote.

A NEW TYPE OF PUMP

We had the privilege recently of witnessing a demonstration of a new steam pump designed by Mr. Atwood of Toronto, and manufactured under his direction by the Atlas Engineering Works of this city. The novelty of the pump lies in the water end, and a radical departure from the usual design is apparent here.

Instead of the usual two decks, containing suction and discharge valves these valves are concentrated in one deck. The cages containing the valves and valve seats fit loosely into the casting, and are held in place by dogs, which in turn are held down by cap screws in the pump chest cover. This arrangement makes it possible for any valve and valve seat to be lifted out bodily after the cover is removed, and any repairs required can be performed in ease and comfort on the bench. The flow of water through the pump can be reversed by simply removing the suction valves and putting the delivery valves in the place, the suction valves taking the place of the delivery, and this change can be accomplished in a couple of minutes.

The arrangement reduces the clearance space in the water end considerably which tends to the efficiency of the pump. The water passages are at the same time freer than in the ordinary design. The pump acted very well on its trials, and the absolutely positive action of the steam valve was demonstrated, it being impossible to stop the pump as long as the steam was turned on. This is of course a very important feature in a simplex pump. The steam valve is also designed by Mr. Atwood. In a future issue we hope to give particulars of this pump, which makes a decided advance in steam pump design.

THE IMPORTANCE OF EMERGENCY CLOSING VALVES

(Continued from Page 24)

breakers, so that the overspeed governor can be tested when necessary, or the oil pressure and steam pressure can be built up without tripping the emergency closing valve.

One type of diaphragm contact breaker is shown in Fig. 6. This is a device whereby a diminution in pressure is utilized to cause a movement of the diaphragm to open an electric circuit,—thereby breaking the circuit through the magnet of the emergency closing valve releasing the swing weight, and tripping the valve shut. Other arrangements and types of pressure control apparatus have been utilized. The one shown is merely typical.

As stated above, the emergency closing valve can be made to close either when the steam pressure in the steam supply pipe to the turbine falls any predetermined amount below the minimum allowable operating pressure, or when the pressure of the lubricating oil becomes dangerously low, or finally, when the turbine overspeeds. It insures instant automatic protection and its importance as a secondary protection for large turbine units cannot be overemphasized.

Practical Electricity for the Power Plant Engineer

By G. R. ARCHDEACON, A.M.I.E.E.

Chapter V

HAVING recently considered the various factors encountered in all electrical circuits, such as current density, voltage, drop heating effect, economical cross sectional area, power in circuit, etc. Let us now briefly consider some practical aspects of the methods of distributing the current by means of a simple wiring system.

Whenever it is desired to instal a system of wiring, either for light or power, it is necessary that a careful survey should be made of the proposed location of the various wires and cables. Special attention should be paid to the accessibility of the wires after installation, whether the location is exposed to the weather, steam, chemical fumes, etc.

Having chosen suitable locations, attention must be paid to the quality of the insulation of the wire and cable, if the location is ideal, then a lower quality of insulation may be employed, resulting in a saving in purchase price of the wire. If on the other hand the location of necessity is exposed to the various elements above suggested, then only the very best class of insulation can be considered.

The insulating material covering the wires or cables, should possess high specific resistance, mechanical strength and flexibility, retentivity of insulating values under changes of temperature and contact with acids, gases and fumes.

As an indication of the wide range existing between the resistance of various coverings employed to insulate the wires it is only necessary to bear in mind that the specific resistance of high insulating rubber is approximately 16,000, this becoming gradually less in the various substitutes for rubber until we get down to as low as only 250 Ohms specific resistance.

Therefore it will be apparent that the quality of the insulation must be carefully considered, and just how suitable it would be for the proposed location in which it is intended to be installed.

Before proceeding with any extensive scheme of wiring it is advisable to call in the local electric light and power authorities, and discuss with them their various rules and regulations controlling wiring systems, and carefully study their by-laws governing the same. By so doing you engender their good will, and will secure yourself against any disappointment after the job is completed, either from the fire underwriters, or the local authorities.

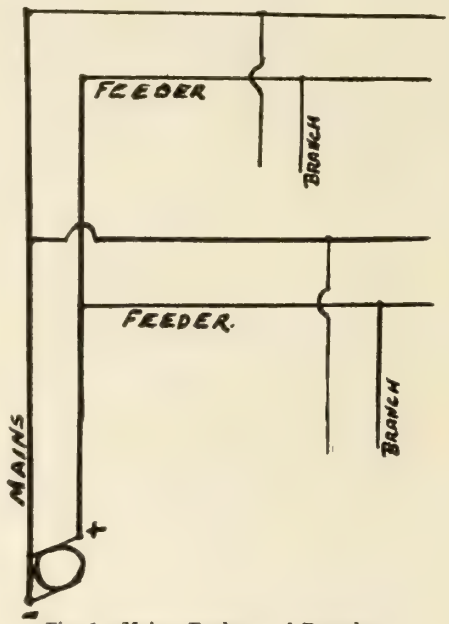

Fig. 1.—Mains, Feeders and Branches.

Elements of a Wiring System

In any wiring system, there are three fundamental elements entering into its construction. These are, mains, feeders, and branches.

Mains are the principal wires connecting the source of supply to the system. These have to carry the major portion of the total current used on the system, and frequently they have to carry the whole of the total current used.

The most careful calculation is therefore necessary in choosing the correct sectional area, thereby preventing any undue loss of power throughout the system.

Feeders are of smaller sectional area than the mains, and are tappings taken off the mains at suitable points along the route of the mains.

Branches are of still smaller sectional area than the feeders and are the parts of the circuit with which we are all more familiar, as it is directly from them that we take our wires for the lamps, toasters, irons, etc. A simple development of these three elements is shown in Fig. (1).

In laying out any wiring system it is of the greatest importance that definite fixed points should be established (after careful calculation) for provisions of centres of distribution, and to such points the mains should be taken and the current distributed therefrom.

As already explained, along any wire of equal cross sectional area throughout its length, and of similar material, the drop of volts will be evenly distributed throughout its entire length. That is to say, suppose the wire in question was carrying a given amount of current, and its length was 1,000 feet., if the voltage drop over the total length was 10 volts, it would only be 5 volts at 500 ft., etc.

It will therefore be apparent that instead of connecting the main to one end of such a wire, if we connected the main to the exact centre of the wire, the current would only have to flow 500 ft. from its source of supply, hence the voltage drop would be halved. This would be the centre of distribution, and can of course be again divided in various sub-centres as required, the idea being to so arrange these centres of distribution so that the pressures in the various heavily loaded circuits are equalized.

So far we have only considered a system that was supplied with only two mains, but there is also another system which provides three mains, this being known as the three wire system. There was also a five wire system developed by the late Dr. Hopkinson of the Manchester University, Eng. The system was employed on the Manchester Corporation Electricity Dept., but after several years "try out" was gradually discarded owing to its many complications, and

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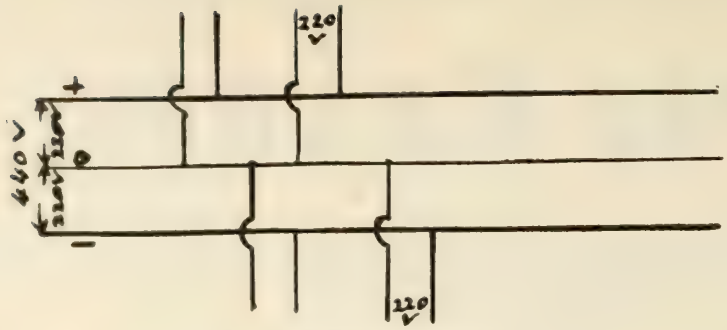

Fig. 2.—Three Wire Distribution.

has been entirely superseded by the more convenient three wire system.

Three Wire System

This is the most modern and the most generally employed system in operation in the distribution of electric power, and is equally adapted for A.C. as well as D.C.

The distribution is effected by means of three mains (Fig. 11), two of the wires are called the outers, whilst the third wire which is arranged between the two outers is called the middle wire or neutral wire.

The outer wires are called the positive outer and the negative outer respectively, and they are twice the sectional area of the middle wire.

The pressure between the outers is twice the voltage of that between the middle wire and either one of the outers. Suppose the voltage between the outers was 440 volts the voltage between the middle and either of the outers would be only 220 volts.

For the ordinary lighting services two wires are taken, one from one of the outers and one from the middle wire, but for the operation of motors, etc., the two wires are taken only from the two outers.

It will be apparent that if all the load was connected, say between the positive outer and the middle wire, the system would be out of balance. Care must therefore be taken to see that each side of the system is equally loaded up. It is not possible in practice to maintain this balance, the system is always out of balance to some extent, and the middle wire is the pathway for the current that is out of balance.

The middle wire must therefore perform the function of a positive wire when the out of balance current comes from one side of the system, and then act as a negative wire when the out of balance current comes from the other side. (Fig. 111).

The greatest advantage of the three wire system over the two wire system is the economy in wire and cable, as it permits a given amount of power to be distributed with about one third the amount of copper that would be necessary on a two wire system.

Consequently the cost of distribution is reduced, as the pressure on the mains may be twice the voltage generally used inside buildings for lighting purposes, this in turn reduces the amperage of such circuits by one half.

Suppose for instance in the case of a two wire system the lighting voltage was 220. The system could be raised to 440 volts for the purpose of running large motors in the building. This would not interfere with the present lighting system, as the 220 volts would still be obtained between the outer and the middle wires.

The reason for using higher voltages on the motor supply is because by doubling the voltage, for any given h.p. the current required will be halved. Another important point to remember is that when the motor is connected across the outers, switching on or off does not affect the volts in the middle wire, consequently there is no disturbance of the lamps connected to the middle wire. Whereas if the said motor was connected between the outer and the middle wire, there would be a rush of current on one side of the system as to so completely render it out of balance that one side of the system would be getting scarcely any voltage through their lamps, with consequent loss of illumination, whilst the opposite side of the system would be getting too many volts resulting in the burning out of their lamps.

It is worth while to just pause a little and consider the reason of the economy involved in using higher voltage for the motor service.

The weight of copper required for the transmission of a given amount of electric power is inversely proportional to the square of the pressure.

Mr. Newton Harrison (in his book on this subject) has prepared a table which demonstrates the above postulate in no uncertain manner. A copy of this is herewith given.

Volts	Circular Mils.	Kilo-Watts.	Length of Wire Ft.	Weight of Wire, Lbs.	Drop Volts.
100	440,000	100	2,000	2,666	5
200	110,000	100	2,000	667	10
400	27,500	100	2,000	167	20
800	6,875	100	2,000	42	40
1,000	4,400	100	2,000	7	50
2,000	1,100	100	2,000	7	100

From an inspection of the above table it will be seen that when transmitting 100 kws a distance of 1,000 ft. it requires 2,666 lbs. of copper for a 5% drop, where as if we increased out voltage to 1,000 volts we only require 27 lbs. of copper. We have only increased the voltage 10 times, yet it has reduced the weight of copper 100 times.

It will therefore be apparent that there is somewhat of an analogy between the economy in the employment of high voltages, as there is in the use of high pressure steam.

When the system of wiring has been decided upon and the installation of same completed, it is necessary to repeatedly have it tested to discover whether any leaks have developed, either through faulty workmanship, or material, or perhaps from some special causes such as acid fumes, steam, water overloading, or too high voltages or other contributory causes.

These tests are generally such as to determine the value of the insulation resistance, this resistance being measured as between—

(a) The earth and the positive wire.

(b) The earth and the negative wire.

(c) The resistance between positive and negative wires.

It will readily be understood that it is practically impossible to entirely eliminate leakage through the insulation, there is always a certain amount taking place, in large power houses the "units unaccounted for" amount to quite large figures, although comparatively small when compared with the total units generated.

It will therefore be obvious that the higher the insulation resistance, the lower will be the "units unaccounted for" as the fewer units will leak through the resistance and become lost without having accomplished any useful work.

As it is impossible to entirely prevent leakage, it is necessary that some safe definite limit should be fixed. This generally is done by the local electric power authority, or the fire insurance underwriters.

In Europe electrical insurance is a very large portion of total industrial insurance, and electrical inspectors visit the various factories at regular intervals, in a similar manner to the boiler inspector, just to "check up" this condition of the insulation resistance.

Many and varied are the instruments used in the making of these insulation tests, the modern tendency is to make the thing so simple and mechanical, and to free the process from all mathematical calculation (apparently to permit of the employment of cheap labour) that such instruments are now extremely delicate, and likewise extremely costly.

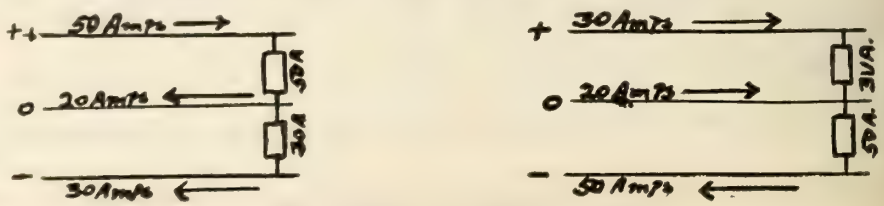

Fig. 3.—Direction of Unbalanced Current.

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However, accurate results can be obtained by the use of a high resistance voltmeter, a spirit of confidence in the eternal verities of Ohm's law, the application of a little thought, and a few simple arithmetical calculations.

Let us therefore tackle one or two examples.

First obtain a high resistance voltmeter, the resistance of which must be known. Suppose this turns out to be 20,000 Ohms.

What are we out to find? How much current is leaking from a certain wire.

What will be the use of a voltmeter when we desire to measure current?

All instruments consume current in the moving of some part of its mechanism (except special electrostatic instruments). Therefore some current is consumed in causing the needle of the voltmeter to move over the scale. Naturally the further the needle moves over the scale the more current it will consume. Therefore the voltmeter is nothing more nor less than a very low reading ammeter. Therefore we can read current values on a voltmeter. But to convey to us any exact knowledge of the amount of current flowing through the voltmeter we must know its resistance. In all high class instruments, the resistance is generally given on a card supplied with the instrument, such card being the certificate of calibration from the testing dept. of the manufacturer.

Let us therefore assume that the resistance is given as 20,000 Ohms. We therefore proceed as follows:—

First Test

To find the circuit voltage.

Connect the voltmeter to the positive and negative poles of the circuit. This will show the voltage between these two wires. Let this pressure be called E, and if E shows 200 volts on the instrument, it may be considered as that small quantity of current which registers 200 divisions on the scale of that particular instrument.

Second Test

Find insulation resistance between the positive wire and the earth.

Connect one side of the voltmeter to the positive wires of the source of supply.

Connect the other side of the voltmeter to the circuit to be tested (first seeing that the circuit to be tested is disconnected from the source of supply).

Connect the negative side of the source of supply to earth.

Let us now consider what we have done. We have simply interposed between the positive pole of the source of supply, and its corresponding negative pole, a resistance of 20,000 Ohms which is again placed in series with the resistance of the insulation of the wires under test. Providing there is no "dead earth" the deflection now obtained on the voltmeter will be considerably less than in the first test because whilst the voltage has remained constant at 200 volts, the resistance of the circuit has been increased from 20,000 Ohms to an amount greater by the value of the resistance of the insulation. Consequently the current passing through the voltmeter will be reduced resulting in a corresponding reduction in the deflection of the needle. All this being a further verification of the truth of Ohm's law.

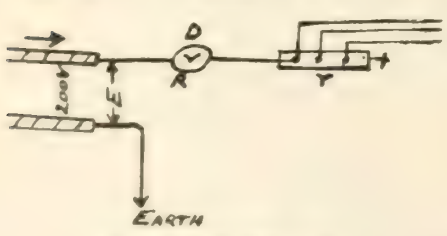


Fig. 4.—Insulation Test.

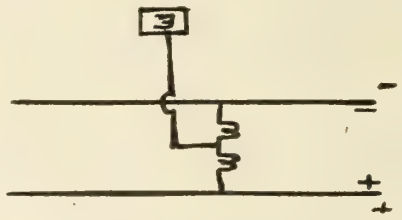
Let us now consider the results of this test.

Let E=Supply voltage=200 volts.

Let R=Resistance of voltmeter=20,000 Ohms.

Let r=Resistance of Insulation.

Let D=Deflection of voltmeter, say 40 divisions.



Leakage Indicator

Assuming in the above test the deflection was 40 divisions, remembering the voltage being constant, the deflection of the voltmeter will be directly proportional to the amount of current passing through it, and therefore inversely proportional to the total resistance.

Therefore—D : E : : R : + r

D would be equal to E if R only were in the circuit, because it would indicate E volts, but the more the resistance of the insulation, the greater the value of r thereby increasing the total resistance R r consequently the value of the deflection D will be reduced.

$$\text{Therefore—} R + r = \frac{E \times R}{D}$$

$$r = \frac{E \times R}{D} - R$$

Substituting the readings obtained we have—

$$r = \frac{200 \times 20{,}000}{40} - 20{,}000$$

$$= 100{,}000 - 20{,}000$$

$$= 80{,}000 \text{ Ohms.}$$

$$= .08 \text{ Megohm.}$$

This would represent the value of the insulation resistance of the circuit tested.

Such a comparative low value would not be considered satisfactory on a simple circuit containing a few lamps, but would be acceptable as a test on the whole of the installation where there were several motors included in the circuit.

Third Test

To find the insulation resistance between the negative wire and the earth.

In this test the supply pressure E is connected to the negative wire of the circuit under test, and the readings and calculations made as in the second test.

Fourth Test

To find the insulation resistance between the whole circuit and the earth.

This is merely a "check test." In this case the positive and negative wires are connected together, and then to the supply pressure E. and readings and calculations made as before.

It is always a sound principle to adopt on any installation, to make up a book containing details of the various mains, feeders, branches, and at regular intervals, say every 3 months to make a complete set of insulation tests, thereby always being in a position to lay your finger upon the defective wire in case of some emergency, when a "dead short" has suddenly developed.

A simple leakage indicator can easily be constructed and mounted on the main switchboard, this could be connected across the main buss bars or across the various mains running from the switchboard, through a small "change over" switch permitting it to be changed over from one set of mains to another, so making it possible to rapidly obtain an indication of any leakage that may be developing.

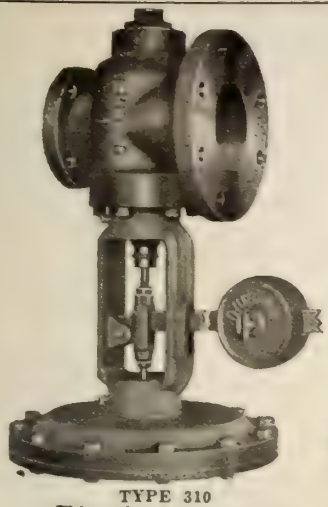
This leakage indicator is made up by connecting two ordinary carbon filament lamps in series across the mains, taking a tapping from the centre point between the two lamps and connecting it to earth.

The voltage of each lamp should equal that of the supply, so that each lamp only gets half its normal voltage, and therefore only just shows a dull red glow when connected in series. When the earth connection is made, providing there is no excessive leakage, both lamps will glow equally.

If any excessive leakage develops on one of the mains, one of the lamps will begin to glow brightly, whilst the other one will lose its red glow entirely. The change so brought about by these altered conditions, will immediately attract the attention to the attendant in the engine room.

The leakage will be on the main to which the darkened lamp is directly connected.

Montreal, Que:—Hart and Tuckwell, 163 McGill St., will erect a warehouse costing $20,000. Cook and Leitch, 358 Beaver Hall Hill, have been given the general contract.



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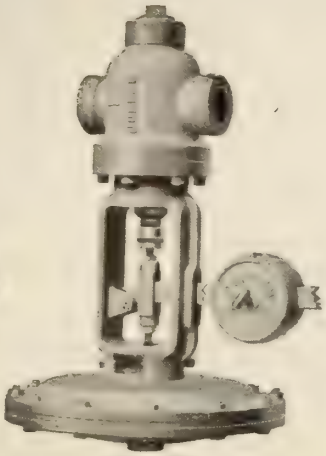

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CATALOGUES

The Reliance Gauge Column Co., have issued circulars describing their high and low water alarm gauge columns. These alarms are operated to give an audible signal by a whistle, or a visible signal by electric light, or both.

We have received from the Canadian Ingersoll Rand Co., Montreal, a bulletin describing their type 15 vertical belt-driven air compressors, and the same type arranged for geared drive from an electric motor. The compressors are of the vertical single-stage, single-acting, self-oiling centre crank type, entirely enclosed. They are made in three sizes, 3 x 3, 3½ x 4, and 4½ x 5 inches. Complete sectional views of the compressor are given in the bulletin, as well as some of the constructive details.

We have received from the Lebanon Boiler Works Bulletin 21, describing their Uniflow boiler. In this boiler, which is of the horizontal tube type, the tubes instead of being arranged in the usual manner, are arranged in three separate groups, having a space between each group. Circulation is upwards between the tubes, while the downward circulation takes place between the groups of tubes in the comparatively large space left there. The firm's address is Lebanon Boiler Works, Philadelphia, Pa.

OMISSION

In the advertisement of D. K. McLaren, Ltd., in the issue of May 5th the addresses of the firm's agencies were inadvertently omitted. In addition to, the head office at 351 St. James St., Montreal, the firm are represented at 194 King St. W., Toronto, and 90 German St., St. John, N. B., under their own name, and by Gormans, Ltd., at 1158 Homer Street, Vancouver, B. C., Edmonton, Alta., and Calgary, Alta.

We have received from the Anderson Foundry & Machine Co., Anderson, Ind., bulletin No. 23 describing the Anderson oil engines. This bulletin describes in detail the construction of these units, which are built in sizes from 1 cylinder 30 h. p., to 6 cylinder 330 h. p. They are of the semi-Diesel type, and are recommended for all ordinary power generation uses.

Indian Air Pump Co., have issued a catalogue describing their pumping equipments for deep well purposes. A general description of the air lift pump, is given, with illustrations of the details of the heads, etc., and some typical installations are illustrated. A glossary of terms used in air lift pumping is included. The Indiana Air Pump Co. is located at Indianapolis, Ind.

ENGINEERING DICTIONARY

The first volume of a most important work, "A Dictionary of Applied Physics," edited under the supervision of Sir Richard Glazebrooke, K. C. B., F. R. S., will be ready for Canadian distribution about June 1st by the Macmillan Company of Canada, Limited, Toronto.

This valuable work will be published in five volumes. Succeeding volumes will appear at intervals of from two to three months. It is arranged as follows:

Vol. I. Mechanics, Engineering and Heat.
Vol. II. Electricity.
Vol. III. Meteorology, Metrology, and Measuring Apparatus.
Vol. IV. Optics, Sound, and Radiology.
Vol. B. Metallurgy and Aeronautics.

It would be difficult to over-estimate the importance of the dictionary. It is the first attempt which has been made to bring within the compass of a single work the latest results of research, and the most approved methods in all branches of the subject.

It will prove invaluable to all manufacturers who are vitally concerned with the question of physics as applied to industry, which has grown enormously in the past few years.

The experience of the war has enforced more strongly the lessons thus taught, and the importance of Applied Science is now universally admitted.

COAL AND ASH HANDLING EQUIPMENT

(Continued from Page 25)

stoker dumps. These hoppers should be built as large as possible and have at least sufficient capacity to hold several hours run of ashes or the ashes which accumulate during the operating cycle of the boiler room. The best arrangement is to construct these hoppers of steel plate lined with hard burned common red brick. Fire brick linings will not do as they deteriorate rapidly owing to the abrasive action of the clinkers and the extreme temperature variation caused by hot ashes and water used for quenching the same. These hoppers should be equipped with gates of sufficient size to pass the largest clinker which operates easily and quickly. Large size gates should be operated by compressed air or steam so as to insure ease, positiveness and speed of operation. These hoppers discharge by gravity into railroad cars, motor trucks which deliver the ashes to a dump or into a small narrow gauge car which delivers the ashes to a skip hoist which lifts the ashes to an elevator bunker from which they are taken away by trucks or boats.

The car used for conveying the ashes from the hopper to the skip hoist should be of sufficient size to hold all the ashes which will flow out of the hopper at one opening of the gate. It should be especially strong and rugged with provision for replacing the car body as it wears out. This car may run on a truck and be propelled by hand, by gasoline motor, by electricity, taking the current from a trolley wire or storage battery. The hand propelled car is, of course, thoroughly dependable. It is, however, unsuited to large installations. The gasoline motor is a balky machine unsuited to boiler room labor. The trolley wire is a source of trouble due to short circuits and occasionally an employee is electrocuted. The storage battery car has now been developed to the point where it is a reliable machine and easy to operate. Charging of the batteries can be done on a systematic routine by having duplicate batteries. This car may either operate on a track or be equipped with rubber tires and operate without a track. It is an especially flexible arrangement without the track and quite satisfactory in all respects. The car should be opened with a dumping body which may be operated by hand or mechanical means if the body is large.

The skip hoist system is about the only successful one for handling large clinker without first breaking the clinker. The ashes do not come in contact with moisture and the maintenance is, therefore, low. As the investment in the car and skip hoist is comparatively high, it can be used only in plants of large capacity.

Regarding the use of chain and bucket conveyors for handling ashes, the abrasive action of the ashes, the chemical effect of sulphur, and corrosion due to water, causes all mechanical conveyors to wear out rapidly, particularly if the moving parts are in contact with the ashes. Furthermore, such conveyors do not satisfactorily handle clinkers.

It is becoming common practice in very large modern plants to install the boilers on the second floor of the plant with ash hoppers of ample capacity. A railroad track is located on the ground level under the hoppers and the ashes are dropped directly into the cars.

This is the most successful and simplest way for handling ashes in a very large plant. There is sometimes trouble however, in maintaining cars when wanted.

Vacuum and Steam Jet Conveyor System

Ashes may be conveyed through a pipe by passing large volumes of air at high velocity through the pipe. This velocity is obtained by the use of an exhauster at the discharge end of the conveyor pipe or by means of a steam jet blowing into the pipe between the point where the ashes are taken in and the point where they are discharged.

The first is known as the vacuum system and the second as the steam system.

Both of these systems permit conveying horizontally and vertically which has the great advantage of delivering the ashes to an elevated bunker—which in turn can deliver by gravity to a truck or other conveyance.

The conveyor pipe should be as large as is warranted by the boiler horse power or the maximum amount of ashes that will be handled in a given period. Experience has shown that an eight in. pipe is about as large as is practicable to use without requiring an excessive amount of steam or power. It is therefore, obvious that the largest clinker that can be handled must be capable of passing through an eight inch pipe. This type of system is, therefore, adapted particularly to the plant which has few clinkers or clinker of a small size. Hence it is a system which is not widely used with high capacity stoker fired plants of even moderate size. Generally speaking they are suited for hand fired plants of 1,000 horse power or less. The ashes may be conveyed horizontally about 300 ft. and elevated about 100 ft. The maximum capacity of such a system is from 8 to 12 tons of ash per hour.

ISOTHERMAL AND ADIABATIC EXPANSION

(Continued from page 31)

the cylinder wall as efficiently as possible to avoid any heat losses through the walls. That is, we wish to get the curve of expansion as close to the adiabatic curve as possible.

The adiabatic curve will always lie higher than the isothermal curve owing to the exponent due to the ratio of specific heats. Therefore in compressing air or ammonia keeping the curve of compression close to the theoretical or isothermal line, lessens the work to be performed by the motor, while in expanding steam in a cylinder of an engine keeping the curve of the diagram close to the adiabatic theoretical line, makes the area of the diagram bigger, and thus more power is developed per stroke.

The actual expansion or compression curve as described on the indicator diagram always lies between these two theoretical curves and the closeness with which it approaches them gives a measure of the thermal efficiency of the apparatus under examination.

APPRECIATION FROM OTTAWA

Editor, Power House:

Kindly accept the hearty thanks of Ottawa Lodge No. 6 C. A. S. E. for your kindness in providing space in your valuable paper for the publicity of our educational work and meetings during the past year.

Yours Fraternally,
R. E. Rodney,
Rec. Sec.

We have received from the Dayton Dowd, Quincy, Ill., their bulletin, No. 248 which supersedes bulletin No. 245. The bulletin is descriptive of the various lines of centrifugal pumps manufactured by the Dayton Dowd people, a large variety being described and illustrated. A number of typical installations are also illustrated.

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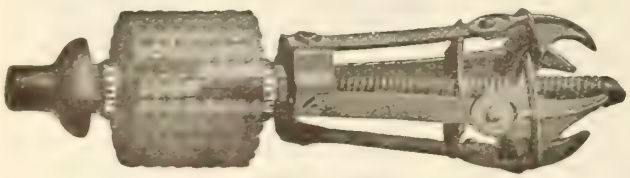

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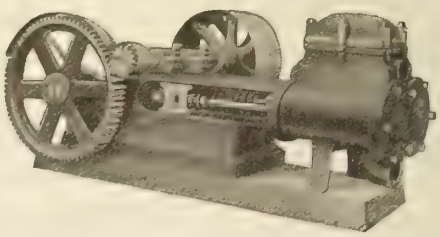

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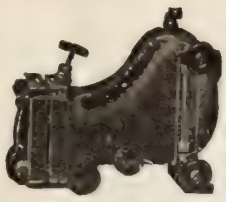

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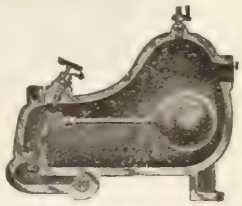

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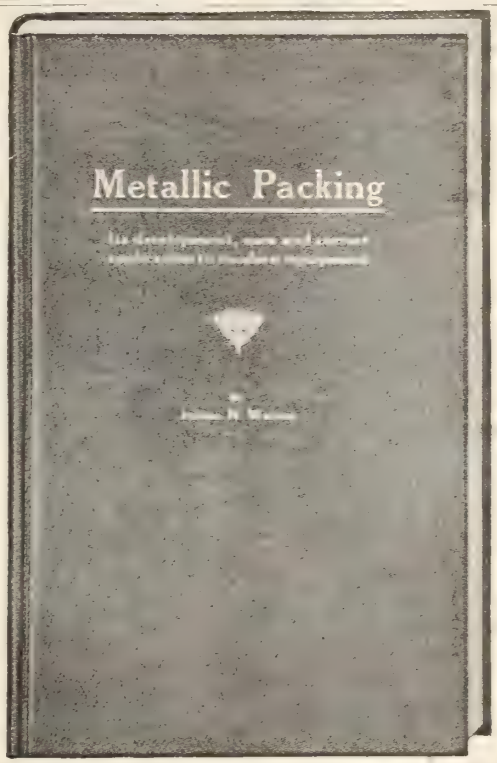

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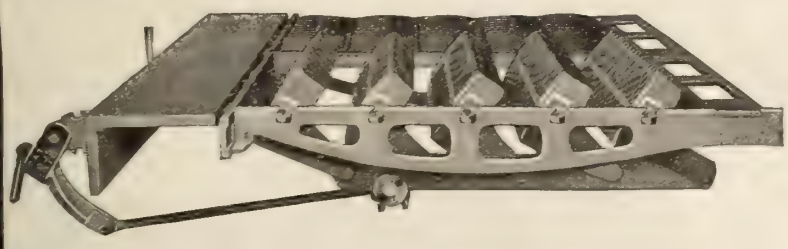

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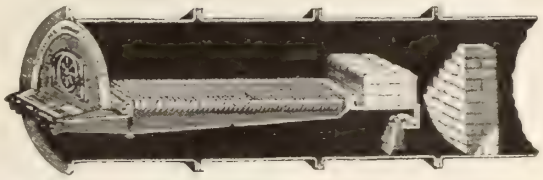

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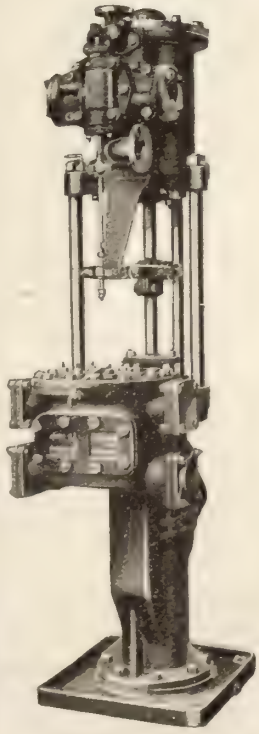

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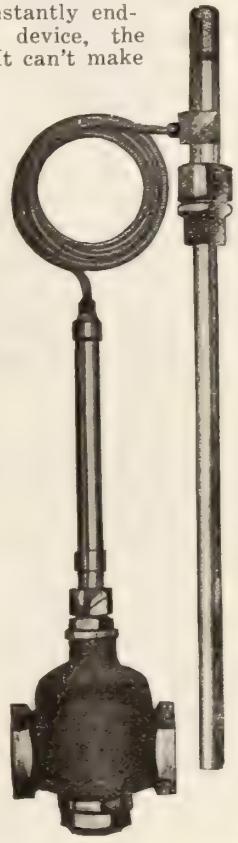

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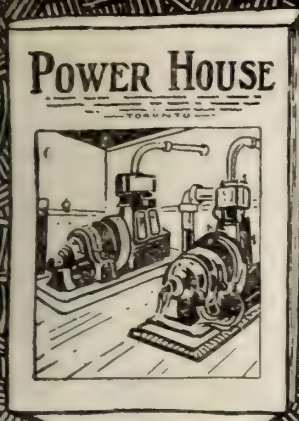

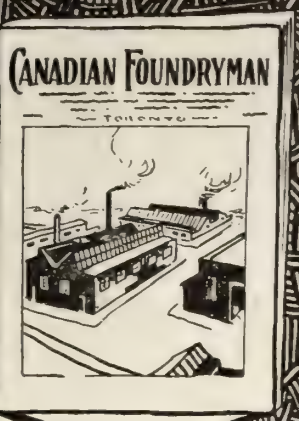

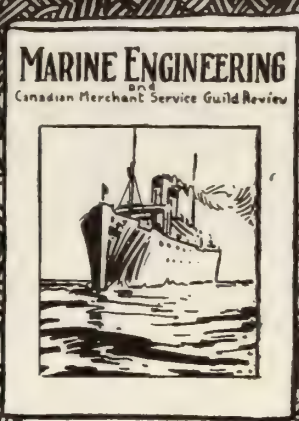

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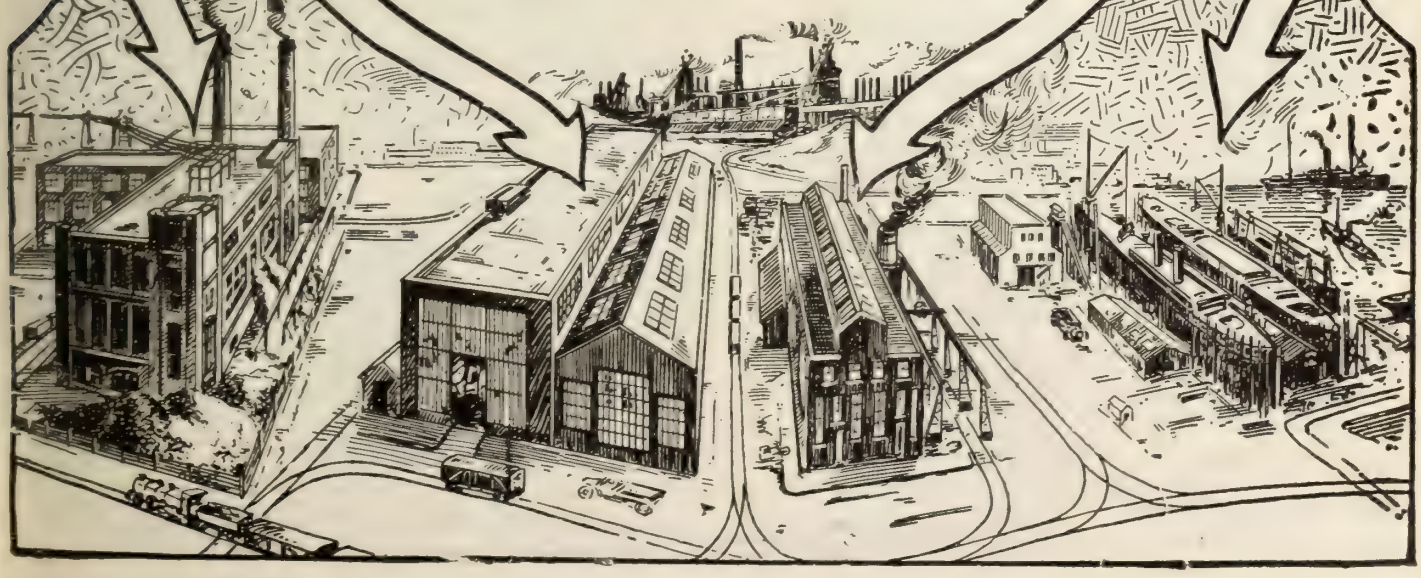

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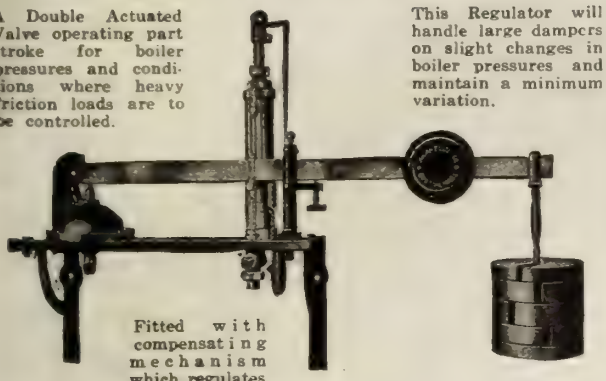

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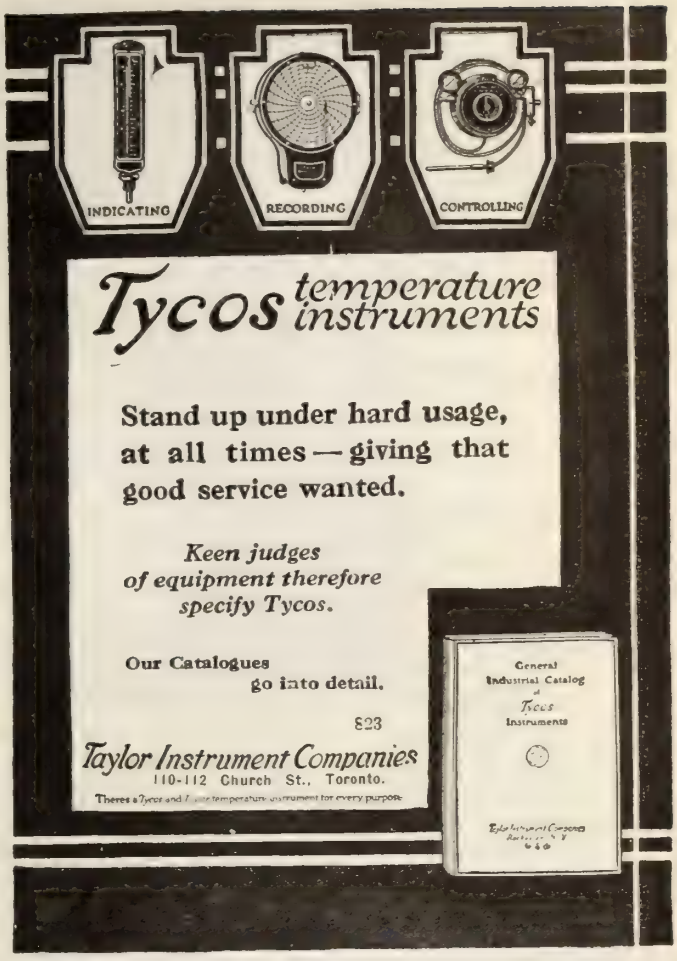
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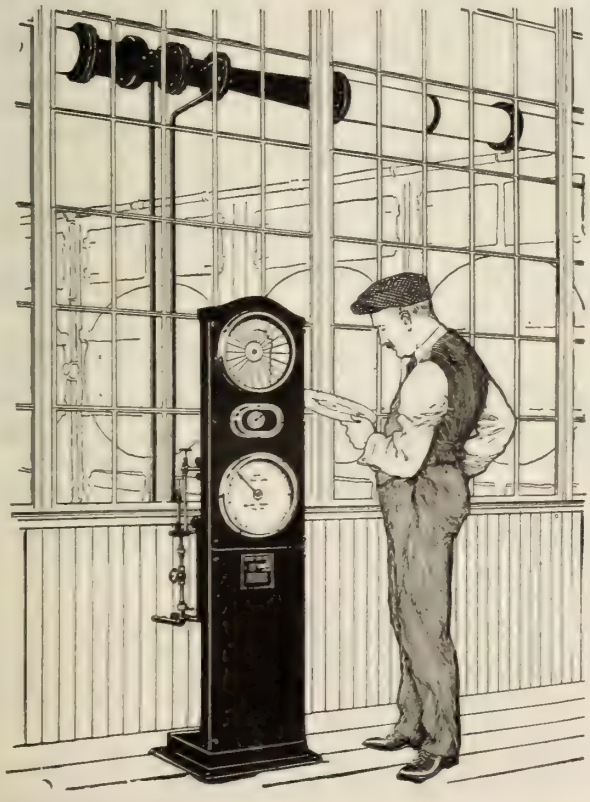

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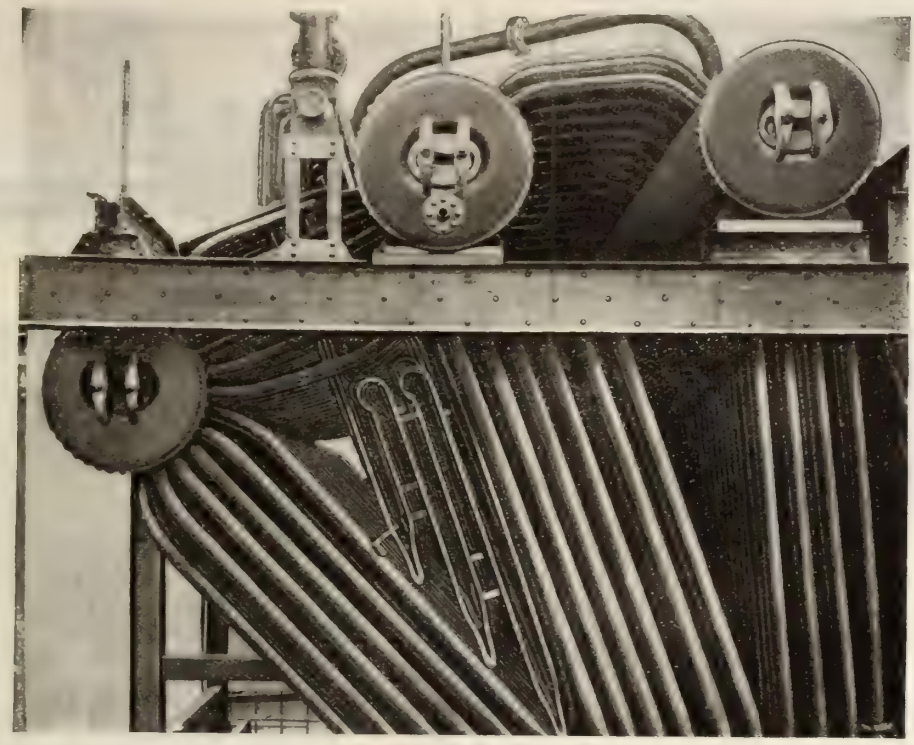

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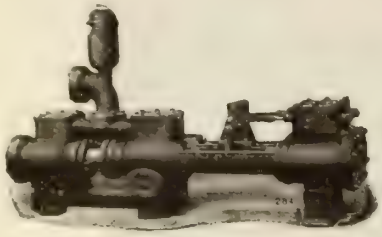

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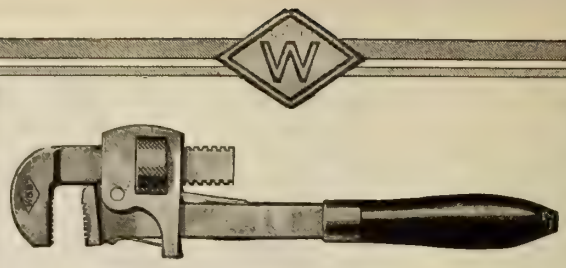

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Are sturdy and dependable — well balanced—positive in grip—powerful in action.
The tough teeth retain their sharpness; they "bite" instantly, yet release readily.
Wood and Steel Handle Patterns—eight sizes, 6 to 48 inches. Ask for booklet.

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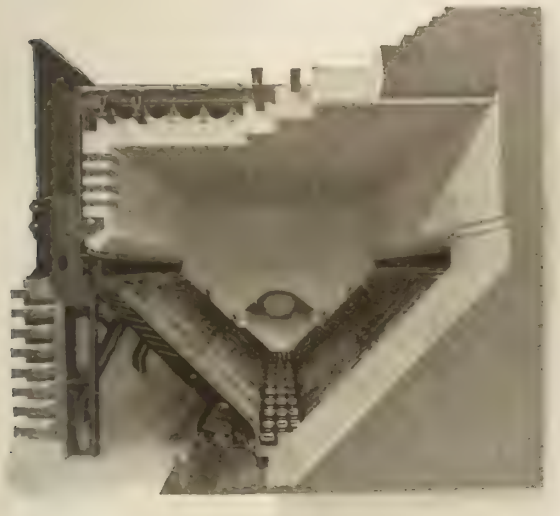

Detroit "V" Type Stoker, Heavy Duty Type, with Detrick Flat Suspended Arch (rear view)

Quartersection, Radial Straight Arch Stoker, showing Coal Magazine and arch support, with removable tuyeres and protecting brick

The special Fire Brick shapes furnished with Detroit Stokers are made from the highest quality refractory material, molded by hand in steel molds and repressed to insure uniformity and durability.

Secure Complete Combustion

You have gone to large expense in installing up-to-date equipment in your plant, to insure economy in operation. How much of the potential energy in your fuel are you actually utilizing in producing steam?

Very much less than you could or should if your boilers are hand fired!

Compare some of the advantages of Detroit "V" Type Stokers over uneconomical hand firing!

A. Hand firing is intermittent, its evenness and effectiveness depending upon the individual skill and attentiveness of the fireman. With Detroit "V" Type Stokers the human factor is eliminated; firing is continuous and uniformly even, assuring high combustion efficiency.

B. With hand firing, one fireman can at the best take care of 250 to 500 H. P. of boilers, whereas with Detroit Stokers the same man can handle 2000 to 3000 H. P. thus reducing labor costs 75 per cent.

C. Detroit "V" Type Stokers burn cheaper grades of fuel than can be used to advantage with hand firing, thus paying for their cost several times over each year.

In addition consider the advantages of control of air admission, thorough automatic cleaning of fires, and smokeless operation, resulting from a Detroit Stoker installation.

Detroit Stokers today represent the best fruits of a practical knowledge gained in the Company's twenty years of successful stoker building, and the recent important developments in the science of combustion. There is a type for every purpose—"V" Type overfeed for natural draft—Single Retort Underfeed for boilers developing up to 300 to 400 H. P.—Multiple Retort Underfeed for large installations.

Take the first step toward reducing boiler room costs. Write for full information.

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Manufacturers of Underfeed Forced Draft and Overfeed Natural Draft Stokers

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POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL, WINNIPEG, VANCOUVER LONDON, ENG.: 88 Fleet Street, E.C. NEW YORK, BOSTON, CHICAGO

Vol. XV.—No. 11 Publication Office, Toronto—June 5, 1922 Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Showing General Scheme of Manitoba Power Company's Development

The Great Falls Power Development on the Winnipeg River.

The construction work now being proceeded with at Great Falls, by the Manitoba Power Company, Limited, signalizes the beginning of the principal link in a chain of potential developments extending from Lake of the Woods to Hudson's Bay, and aggregating several millions of horsepower.

Concrete will, of course, play an important part in the entire project. The dam, on the west shore to the power house, 750 feet long and with maximum depth of 75 feet, will be of the usual solid concrete non-overflow type.

The power house will be 110 feet wide, 380 feet long, and will have a maximum height of 145 feet. The foundations will be of reinforced Concrete.

The design of the plant is modern in every respect, and in physical dimensions and quantity of water used, the turbines are the largest ever installed.

Sir Augustus Nanton is president of the Manitoba Power Company, and Mr. A. W. McLimont, vice-president and general manager.

Mr. Julian C. Smith is supervising engineer; Messrs. L. J. Hirt, R. S. Lea and C. O. Lenz are consulting engineers. Mr. F. H. Martin is chief engineer and designer.

The contractors are Fraser-Brace, Limited.

CANADA CEMENT COMPANY LIMITED

Canada Cement Company Building

Phillips Square Montreal

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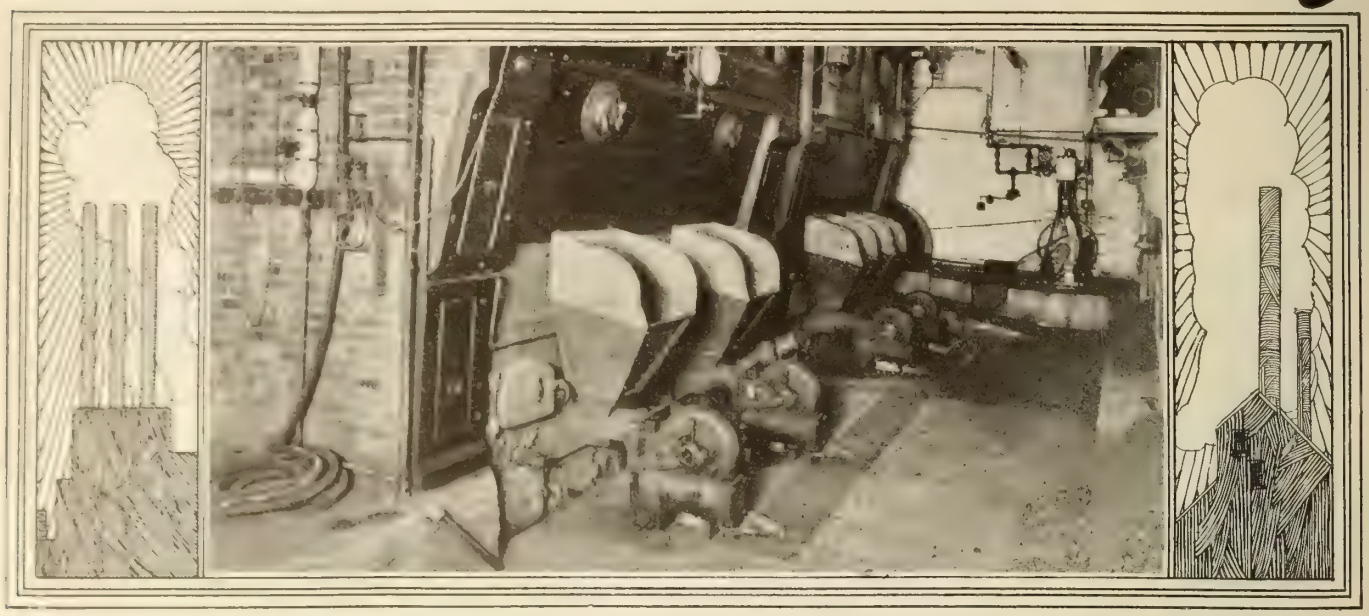
CANADA CEMENT CONCRETE FOR PERMANENCE

Detroit Single Retort Stokers Effect Remarkable Fuel Saving



THE Detroit Single Retort Underfeed Stokers illustrated above, are installed in the power plant of a prominent Cincinnati shoe manufacturing company.

This power plant, containing water tube boilers and another type of stokers, had been operated for a number of years by a very efficient force, who, in five years, succeeded in reducing the fuel consumption from approximately 12 tons per 10 hour day to 10 tons per 10 hour day under the same load conditions.

Two years ago the old equipment was discarded, and water tube boilers of the same make installed. These were equipped with the Detroit Single Retort Underfeed Stokers shown.

This installation is in daily operation and the fuel consumption has now been reduced to 6 tons per day. A saving of 40% in fuel has thus been secured.

Uniform steam pressure is now maintained and recent tests under every-day operating conditions show an overall efficiency of boiler and stoker better than 75%.

Similar savings may be possible in your plant. Let us investigate your conditions and submit recommendations.

In addition to the Single Retort machine we manufacture V-Type Stokers for natural draft, and Multiple Retort Underfeed Stokers for large boilers. Write for full information outlining your boiler conditions.

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DETROIT STOKER COMPANY

Underfeed Forced Draft and Overfeed Natural Draft Stokers

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DETROIT UNDERFEED STOKERS

Files Hand Stokers Getting Results

PANTHER RUBBER COMPANY, LIMITED

GENERAL OFFICES AND FACTORIES
SHERBROOKE, QUE.

Rec'd Sept. 26/21.

SHERBROOKE, CANADA September 23, 1921.

The Waterous Engine Works Co. Ltd.,
Brantford, Ont.

Gentlemen:

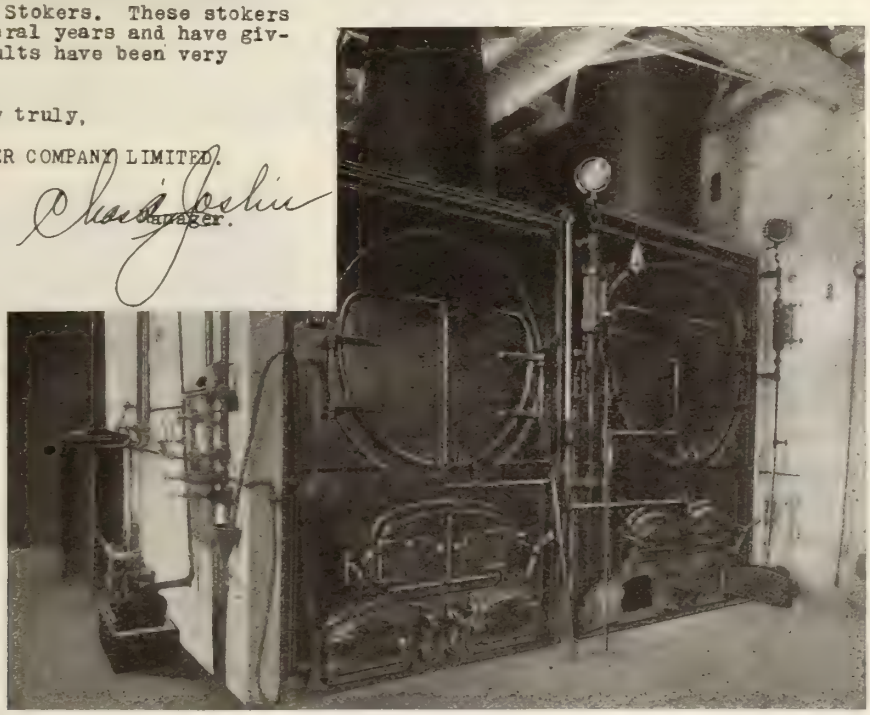
In reply to your letter of the 8th instant we have in our plant the Files Stokers. These stokers have been in operation for several years and have given excellent service. The results have been very satisfactory.

Yours very truly,

PANTHER RUBBER COMPANY LIMITED.

Manager.

CAJ/RMK



It is the uniform excellent service and general satisfaction that have caused progressive men to select **Files Stokers.** These are typical of the more complete data we have compiled:

One installation (3,600 H.P.) saved enough coal to pay for their stoker investment in five months.

A Files installation operated for five months continuously at an average rating of 223%—doubling their steam output.

Files stokers increased efficiency of one plant sufficiently high to warrant discontinuance of two out of eight boilers.

Here is a ready explanation of these achievements:—

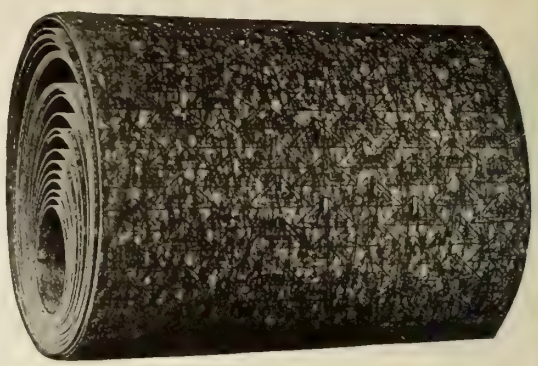
1. **Complete volatilization of green coal, causing intensified combustion and smoke dissemination.**
2. **Correct distribution and proper proportion of air according to load carried.**
3. **Fuel bed continuously kept clean, uniform and rich.**

Given the opportunity we will be glad to present these facts for your complete satisfaction.

The Waterous Engine Works Company, Ltd.

Brantford, Ontario

For Tight Joints



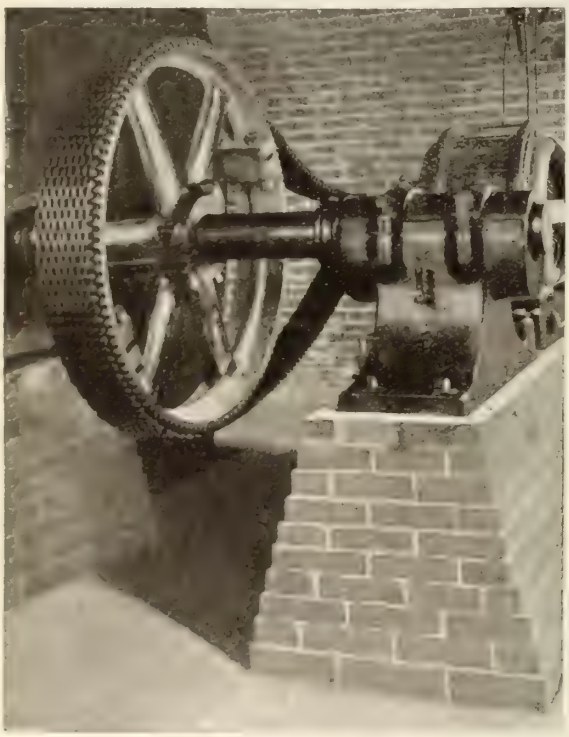
Durabla compressed asbestos fibre sheet packing makes tight joints on steam, water, air, oil, ammonia and acids at all temperatures and pressures. Joints can be broken without injury to gaskets. It will not burn out, blow out, pulp at the joints; requires no following up and is not affected by vibration or condensation. Durabla Packing meets all conditions of shipping and storage.

Made in Canada by Canadian Durabla, Limited

and sold on a service basis by

The Canadian Fairbanks-Morse Co., Limited

DURABLA



CONSERVE POWER AND SPACE WITH LINK-BELT SILENT CHAIN

"BY using Link-Belt Silent Chain Drives on my two 50 H. P. induction and exhaust fans, I secured a compact arrangement, eliminating the building of an extension to my fan room, which would have been necessary for leather belt centers. This would have proved costly"—Mr. Wilcox, Alliance Clay Products Co., Alliance, Ohio.

Are you wasting floor space unnecessarily with your present transmissions?

Link-Belt Silent Chain is compact, flexible, durable, 98.2% efficient on actual test, and combines in one drive the best points of flat belts and gears, minus their disadvantages. Send for our book No. 310.

CANADIAN LINK-BELT COMPANY LTD.

TORONTO--Wellington and Peter Sts.
MONTREAL--10 St. Michael's Lane.

LINK-BELT

Don't Take Our Word For

GUTTA PERCHA & RUBBER, LIMITED
TRADE P.M.S MARK
TORONTO, CANADA

"P.M.S" BELTING

Try it! Test it! Compare it!

We court investigation. "P.M.S" Belting is recommended, and sold strictly on its merits—of course; it's well-made of exceptional materials. The toughest of Sea Island Cotton, rubber-friction-surfaced to make it non-slip and assure the maximum transmission of power, is the basis of "P.M.S" excellence. But, to convince yourself, just try it! Test it! Compare it with others! Give it the severest trial you like, so long as it's a fair one. Then, you'll appreciate "P.M.S", as we know it—practically perfect belting.

Manufactured Exclusively by

Gutta Percha & Rubber, Limited

Head Offices and Factories, Toronto

Branches in all Leading Canadian Cities

MAGNOLIA ANTIFRICTION METAL

TRADE MARK

New Truths and Old Fallacies

A PARTING SHOT

Now, in conclusion, please excuse us for paying our respects to certain competitors whose shibboleth is "just as good," or "the same thing" as Magnolia.

Admit, if you please, for the sake of argument, that they know, at least, the approximate formula of Magnolia—then what? Does an analysis show our foundry practice and thermal treatment? Does it show our graphite treatment? Have most of these people ever heard of impurities of low atomic volume, or have they the remotest idea as to what an eutectic is, as applied to babbitts?

Their literature, that we have seen, denotes their entire ignorance of these subjects, and never, by any chance, give comparative figures of tests, with and without lubrication, or have anything to say regarding co-efficients of friction. Apparently the extent of their information is confined to a knowledge of the formulas of the general run of "commercial babbitts," and the finer points of compounding are evidently not dreamt of in their philosophy.

Some of them will make any claim and quote any price to obtain business, without regard to the interest of their customers, and this is often done by well-meaning people who are uninformed on the subject.

No other concern than Magnolia Metal Company has ever given out so much useful information regarding babbitt metals. When it comes to the cold analysis of figures and facts, is not the discreet silence of other concerns a fair inference that they have nothing of equal value to report?

We lay our cards on the table face up, and ask that our competitors be at least required to do the same thing.

It never pays to buy the cheaper grades of anything, as a dime saved in price is often a hundred dollars lost in efficiency.

(Continued next month)

Sold by leading dealers everywhere or by

MAGNOLIA METAL CO.
OF CANADA, LIMITED

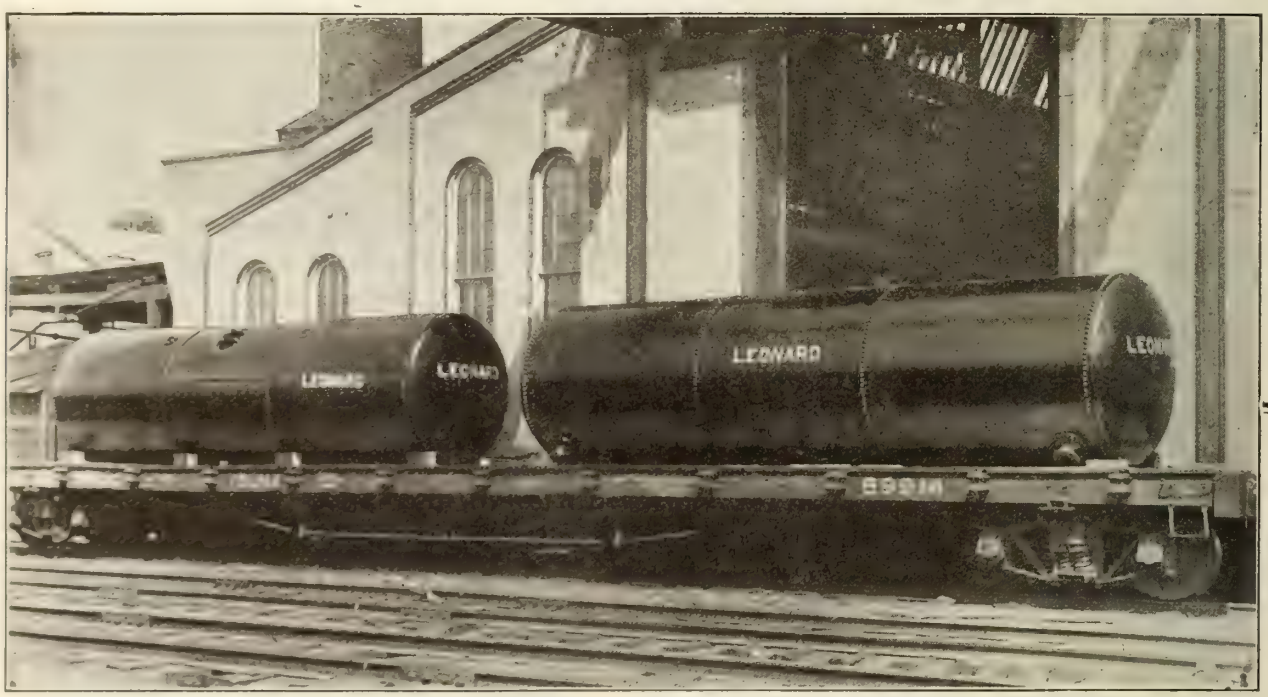
Office and Factory:

MONTREAL: 37-39 SHANNON ST.

For copy of complete article:

"New Truths and Old Fallacies"

Address Our Montreal Office.



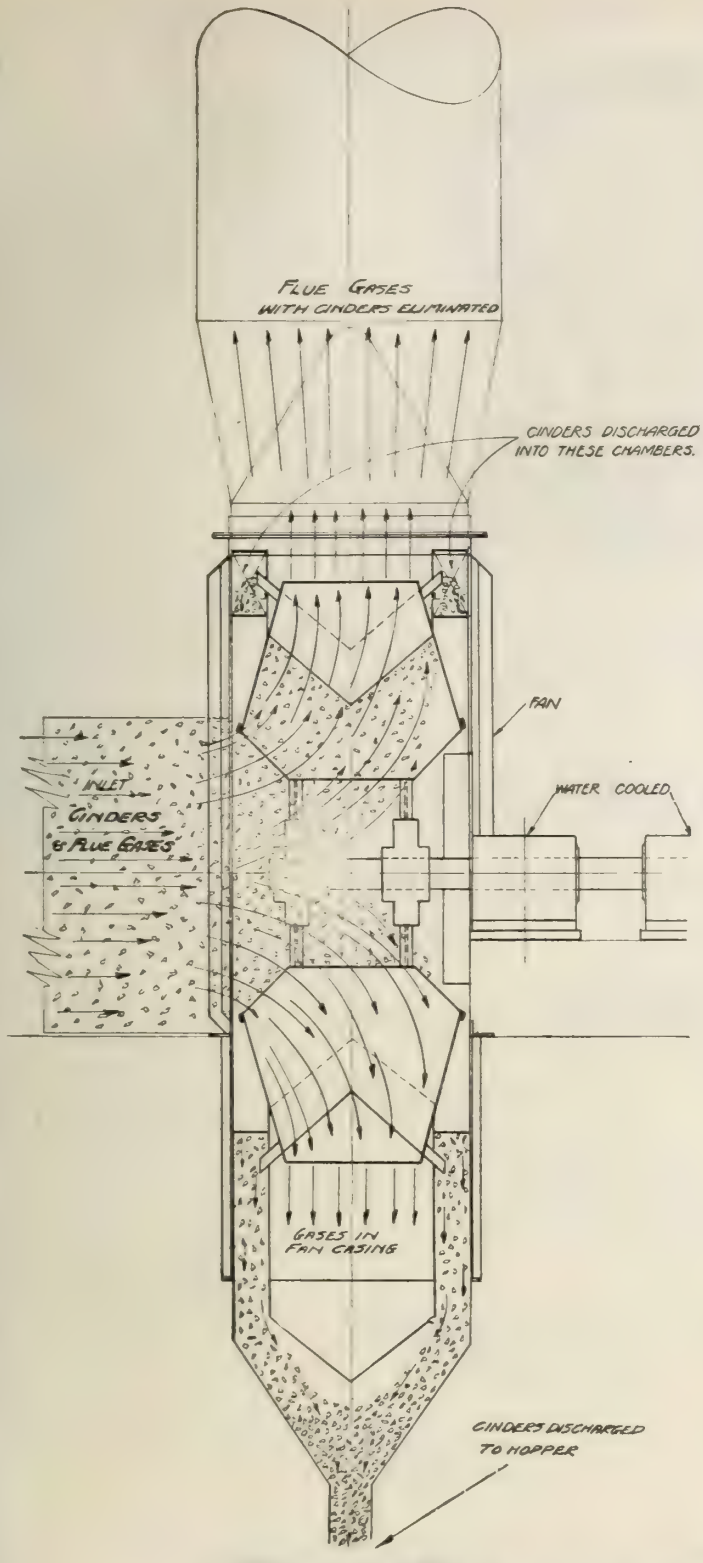
Two 72 Inch x 24 Ft. Pressure Tanks

E. LEONARD & SONS, LIMITED

Head Office and Works: London, Canada. Branches from Coast to Coast

Established 1834

LEONARD



This is how the Cinder Eliminating Induced Draft Fan Works

The fan casing is directly connected with the flue. Everything that gets into the flue—fine or coarse material, gases—everything, must first go through the fan. There are a series of guiding vanes running across each of the fan blades which lead the solid material to the inclined channels on each fan blade. The solid material runs into these channels and is then thrown out by centrifugal force into a "dead" space between the fan and the casing; this solid matter falls into a hopper and can be conveyed where desired, while the gases only go up the stack.

The revolving fan at the same time furnishes a most efficient induced draft.

Two hundred and fifty pounds of solid matter an hour was collected by each fan in one New York plant.

Write for further information

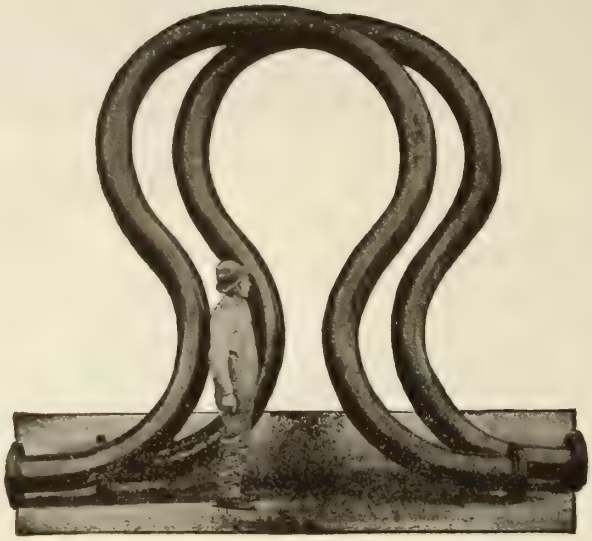
B. F. STURTEVANT COMPANY OF CANADA LTD.

Montreal — Empire Engineering & Supply Co., Edmonton, Alberta

Galt

Toronto — Kipp-Kelly, Ltd., Winnipeg, Man.

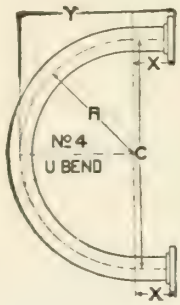
625

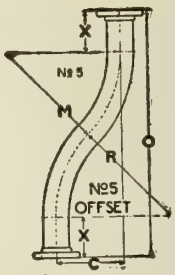


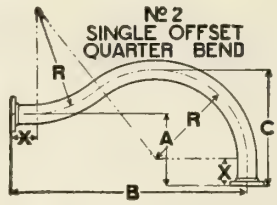
CRANE

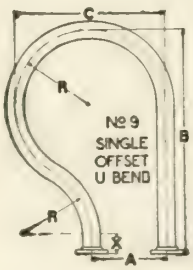
PIPE BENDS

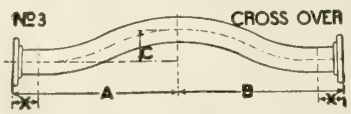
ARE THE STANDARD

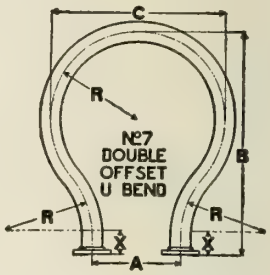


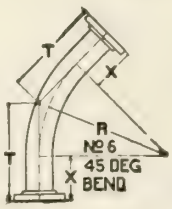


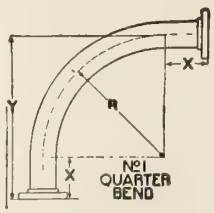












Manufacturers of Valves, Fittings and Piping Equipment and Distributors of Pipe, Plumbing and Heating Supplies.

Branches and Warehouses:
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HAMILTON, LONDON, WINNIPEG,
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The Importance of Keeping the Bearing Surface of a Rod Well Lubricated

Most packings contain little or no lubricant, and present a friction producing surface to the rod, which wears a hollow in rod where it passes through the stuffing box, and quickly destroys the packing itself.

TRADE MARK
"PALMETTO"
REG U S PAT OFFICE

has lubricant forced into each single strand under pressure before braiding. This lubricant works to the rod and keeps the bearing surface covered with a film of graphite grease, reducing friction to the lowest point.

The perfect lubrication of "Palmetto" packing prevents the wear of rods, and is one of the reasons why "Palmetto" gives Longer service than other packings.

Let us send working samples of braided and twist "Palmetto" so you may understand the value of a perfectly lubricated packing.

GREENE, TWEED & CO.

Sole Manufacturers **109 Duane St., New York**

CANADIAN AGENTS:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

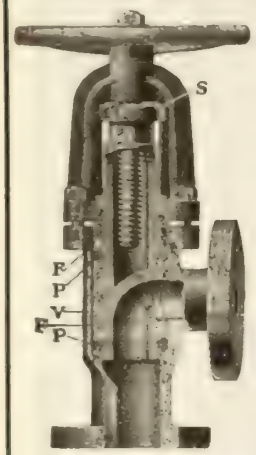
No Seat to Leak—

the Outstanding Reason for the Success of the

YARWAY

Seatless Blow-Off Valve

(Formerly the Simplex)



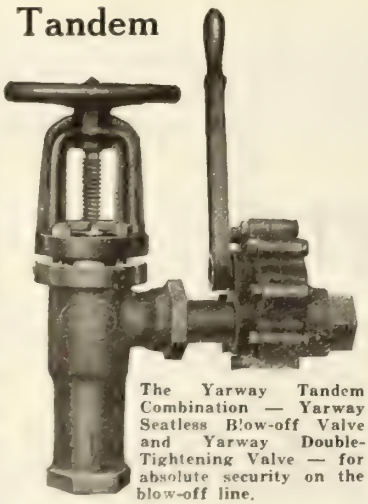
After the YARWAY SEATLESS BLOW-OFF VALVE has closed, shoulder S on plunger V engages the loose follower gland F. A hard turn of hand wheel then compresses packing P above and below the port, making an absolutely tight valve.

No blow-off valve seat has yet been made that can successfully withstand the cutting, scoring, destructive action of grit and sediment forced against it under high pressure. Consequently, the ordinary blow-off valve is a source of constant trouble and expense.

Because the Yarway Seatless Blow-off Valve eliminates this most troublesome part—because it stands up in service for years without repairs—because, being a slow-opening valve, it precludes all possibility of water hammer and ruptured blow-off piping—and because it is carefully made of sturdy material, it has won success in hundreds of well-equipped plants in this and other countries.

The Yarway Tandem

The combination of a slow opening plunger valve which can be depended upon to keep the line tight and prevent water hammer, and a quick opening lever operated valve for use in case of emergency or repair, has gained widespread favor recently. For such service the Yarway Tandem Combination has proved particularly successful.



The Yarway Tandem Combination — Yarway Seatless Blow-off Valve and Yarway Double-Tightening Valve — for absolute security on the blow-off line.

Details in Booklet B 410

·YARNALL·WARING·COMPANY·

7622-28 Queen Street

Chestnut Hill··Philadelphia

Representatives in all Principal Cities

The Complete Line of Efficient and Economical Engineering Catalog Keystone Mining Catalog or Chemical Catalog

YARWAY SEATLESS BLOW-OFF VALVE · YARWAY DOUBLE TIGHTENING BLOW-OFF VALVE · YARWAY BOILER SKIMMER · YARWAY ADJUSTABLE SPRAY HEAD · YARWAY HYDRAULIC VALVE · YARWAY UNLOADER · YARWAY LEA V-NOTCH METER · YARWAY PIPE CLAMPS ETC

YARWAY POWER PLANT DEVICES

The stoker that keeps everlastingly at it

BY KEEPING everlastingly at it in hundreds of plants, Jones "A-C" Stokers have won nation-wide success.

The Jones "A-C" never fails to give a day's work—and that means a 24 hour day if the plant load requires it. This high-duty stoker is so simple in design and so rugged in construction, that it easily stands the punishment of heavy, prolonged overloads and peak loads ranging to 300 per cent. of rating and over.

Simplicity—and the staying power that goes with simplicity—is gained without a sacrifice in combustion efficiency. For simplicity is an inherent advantage of the correct application of the under-feed principle of combustion—the principle that was first introduced in the Jones Stoker.

Thoroughly, but not too technically, the new book "Ten Points of Jones Superiority," explains the advantages of the Jones "A-C" Stoker in a way that will interest any Canadian plant operator. When shall we send your copy?

Under-Feed Stoker Co. of Canada,

Limited

146 King Street West, Toronto

British Columbia:
E. A. Earle, Limited, 846 Hastings St. W., Vancouver, B.C.

Quebec and the Maritime Provinces:
The Cleaton Co., (Canada), Ltd., 403 Southam Bldg., Montreal, Que.

Alberta and Western Saskatchewan:
Mr. J. Twomey, Camrose, Alberta.

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W. W. Hicks & Co., 567 Banning St., Winnipeg.

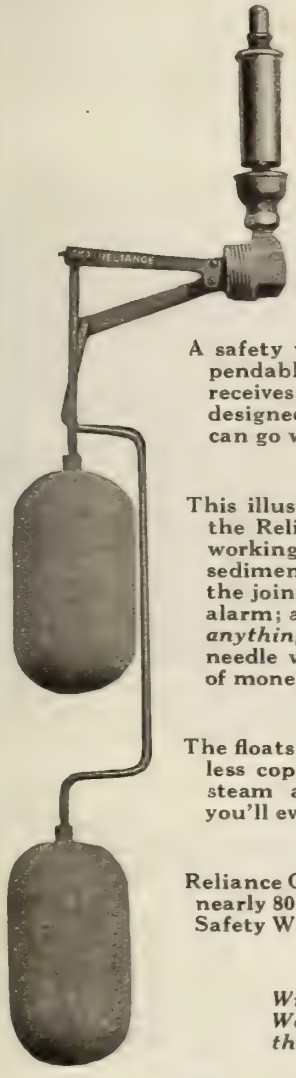
Jones "A-C"

Made in Canada— by Canadians

Sold for Canadian Money at par.

The original 35 years ago Standard ever since

positive warning that the water in your boilers has reached a dangerous level



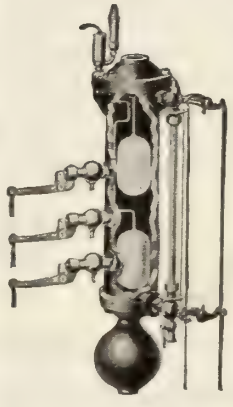
A safety water column must be absolutely dependable—*ALL* the time. Even though it receives only perfunctory care, it must be so designed and built that practically nothing can go wrong with it.

This illustration shows the vital mechanism of the Reliance high and low water alarm. All working parts are up out of the water; no sediment or foreign deposits can clog or stiffen the joints. There is a separate float for each alarm; and the low alarm float is so set that if *anything* happens to it the whistle blows. The needle valve which the levers operate is made of monel metal—you know what that means.

The floats are Reliance made of reinforced seamless copper, and every one factory tested to steam and water pressures far higher than you'll ever subject them.

Reliance Columns *are* dependable. The fact that nearly 80% of all the columns in use are Reliance Safety Water Columns is considerable evidence.

Write to us for full information. We are preparing a new catalog that will be ready soon.



Here is the complete column cut away to show the float mechanism. The cost of this safety device is so low and its service so important, that no boiler plant — one boiler or fifty—can afford to be without it.

Reliance

STEAM SPECIALTIES

THE RELIANCE GAUGE COLUMN COMPANY

TRADE MARK
REG. IN U.S.PAT.OFF.

LINDE

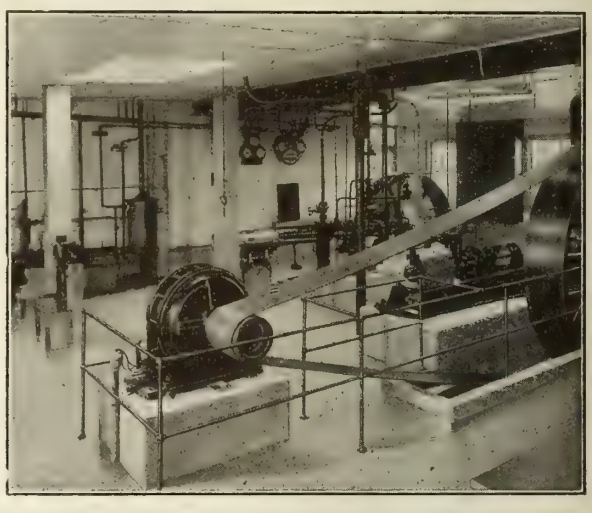
Made in Canada

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

CANADIAN PLANET ENGINEERING COMPANY LIMITED

WINDSOR ONTARIO

Manufacturers of

PLANET MECHANICAL SOOT BLOWERS

Dealers in power plant specialties, mechanical and hand-fired stokers, valves, steam and vacuum traps, gauges and recording instruments, refrigerating machinery.

MONCRIEFF'S

Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. British Made.

"UNIFIC" WATER GAUGE

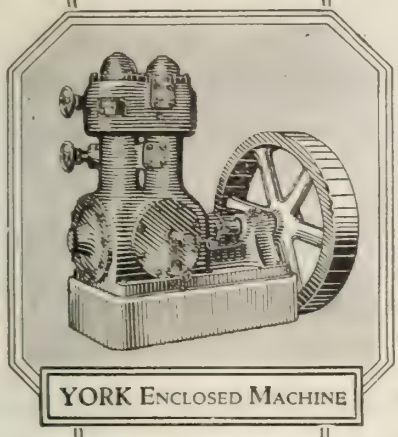
JOHN MONCRIEFF LIMITED

PERTH, SCOTLAND

GLASSES

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA



YORK ENCLOSED MACHINE

50% of the Refrigerating Machinery sold annually in the U.S. is YORK Equipment

Evidence of Merit

No company can establish a record of selling approximately fifty per cent. of all the refrigerating machinery sold annually in the United States unless there is merit in the product—merit of the kind that wins new customers and retains the confidence of the old ones.

Fair dealing, prompt service, furnishing apparatus that will fulfill the guarantees and by charging prices consistent with the quality of the product, all have helped to increase the sales of York Machinery and Apparatus.

Our thirty-six years of experience in building Ice Making and Refrigerating Machinery of recognized worth, have enabled us to help others solve their refrigeration problems—we may be able to help you.

YORK MANUFACTURING CO.
Ice Making and Refrigerating Machinery Exclusively
YORK PENNA., U.S.A.

Canadian Representative:

CANADIAN ICE MACHINE COMPANY, Limited

Toronto: Villiers & Munition Sts. Winnipeg: 1415 Whyte Ave.
Montreal: 324 Craig St. West. Vancouver: 1158 Homer St.

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types; Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

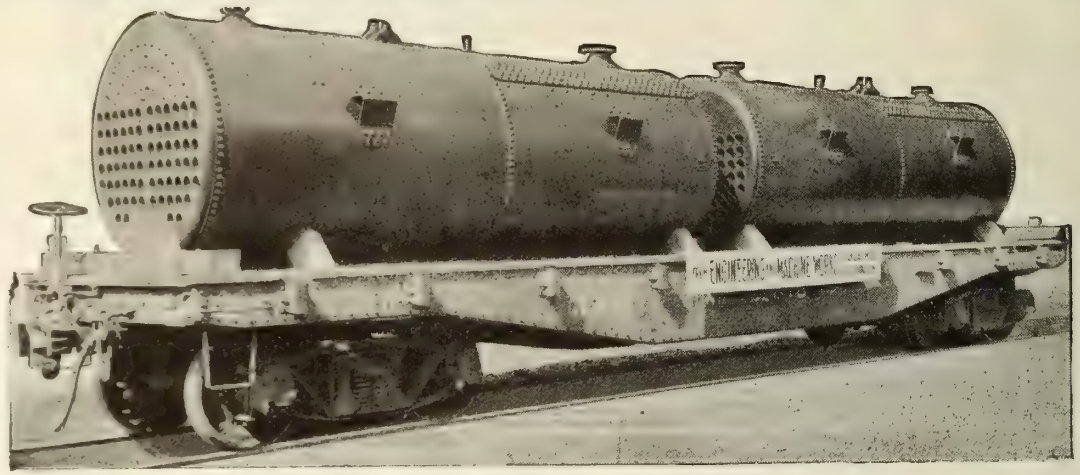
Jamison

HEAVY DUTY
Cold Storage Doors
Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
(Formerly Jones Cold Store Co.)
HAGERSTOWN - MARYLAND, U.S.A.



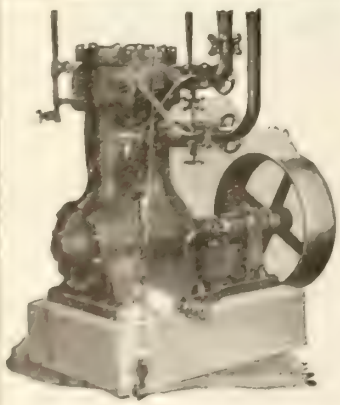
Not merely a "good boiler," but the best boiler built.

That's the quality you want—if you can buy it right. Well—we have had 36 years of high quality Boiler building and our shop practice is refined to the highest point of efficiency. Our prices right now are mighty inviting. Yes—now is the time to buy!

Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices:
Hall Machinery Co., Sherbrooke, Que., and Birks Bldg., Montreal.



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada
CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company
242 Beecher St. - - - Milwaukee, Wisconsin

Why *Brick* Insulation
at
Provincial Paper Mills

FOR the simple reason that only in brick form can insulation be permanently built into boiler settings. Loose fillings lack structural strength and stability. The insulation to be efficient, permanent and economical, should be an integral part of the construction.

Nonpareil Insulating Brick
For Boiler Settings, Furnaces and Ovens

are made in standard fire brick shapes and sizes. They bond with the refractory and common brick to form a solid wall. The insulation is built in. It cannot settle or break away. It is not affected by jars or vibrations or by the strains of expansion and contraction. It is permanent insulation. And it is economical insulation for the Nonpareil Brick simply take the place of an equal number of common brick and their use does not call for additional construction or for skilled labor.

As for efficiency, a 4½-inch course of Nonpareil Brick reduces by about two-thirds the heat loss by conduction and radiation from walls and arches. The saving in fuel, the greater uniformity of temperature and the more comfortable working conditions in the boiler room, repay the cost of insulation in a year or less.

The uses and advantages of insulation in brick form are explained in the 72-page book, "Nonpareil Insulating Brick," which is sent free on request. Write for it.

Armstrong
Cork & Insulation Co., Limited
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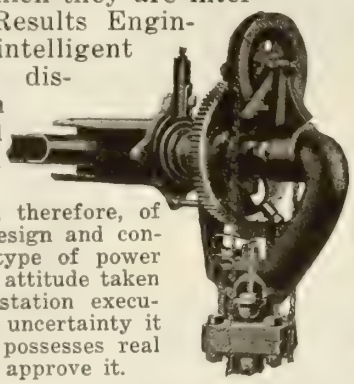
Diamond Valv-in Head Soot Blowers Save Fuel Labor and Steam in the Big Central Stations

AS a group the most critical buyers of power plant equipment are the big central stations. They have every facility for measuring the exact performance of the machines in which they are interested, and their Results Engineers are keen, intelligent judges, quick to discriminate between real and fancied efficiency and economy.



One of the real tests, therefore, of any improvement in design and construction of a given type of power plant equipment is the attitude taken toward it by central station executives. If there is any uncertainty it is not taken up—if it possesses real merit they are glad to approve it.

We do not know of any piece of power plant equipment which has ever received from central station executives in the same length of time the cordial welcome and hearty endorsement which has been accorded Diamond Valv-in-Head Soot Blowers.

Over 2,000 units of this new type of soot blower have been purchased by over 125 central stations within the past eight months. Such representative operating companies as Commonwealth Edison, Detroit Edison and Pennsylvania Power and Light have ordered from 126 to 176 units.

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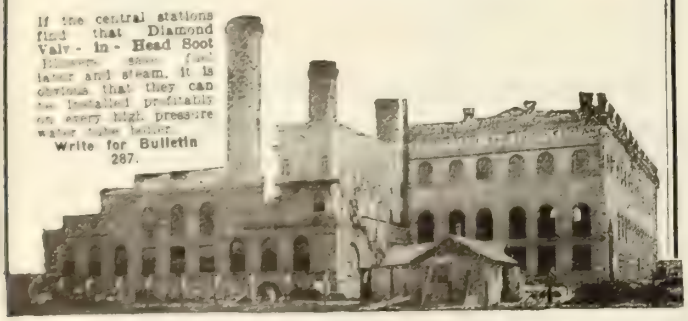
(Also see mention of the article on Provincia iamond Valv-in-Head Soot Blowers in Paper Mills in this issue of Power House.)


If the central stations find that Diamond Valv-in-Head Soot Blowers save fuel, labor and steam, it is obvious that they can be installed profitably on every high pressure water tube boiler.
Write for Bulletin 287.

DIAMOND SPECIALTY LTD.

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VALV-IN-HEAD SOOT BLOWERS

WILLIAMS' "VULCAN"

Drop-Forged

CHAIN PIPE VISE

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Compact, light, rapid in action and easily attached to bench or post. The strongest and most efficient pipe vise on the market. 3 sizes, for ⅛ to 8 inch pipe.

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J. H. WILLIAMS & CO., Limited

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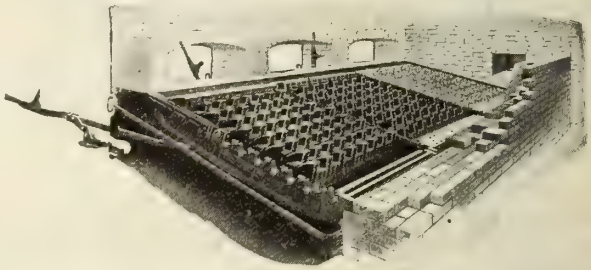
CoKal 'Chainless' Stokers

Self Cleaning ***Hand Operated***



CoKal stokers can be furnished with or without hopper feeds

EASY TO OPERATE	SAVE COAL
INCREASE CAPACITY	INCREASE EVAPORATION
ELIMINATE SMOKE	GUARANTEE RESULTS
HIGH RATINGS	UNIFORM FIRE BED
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The Best Hand Stoker Built

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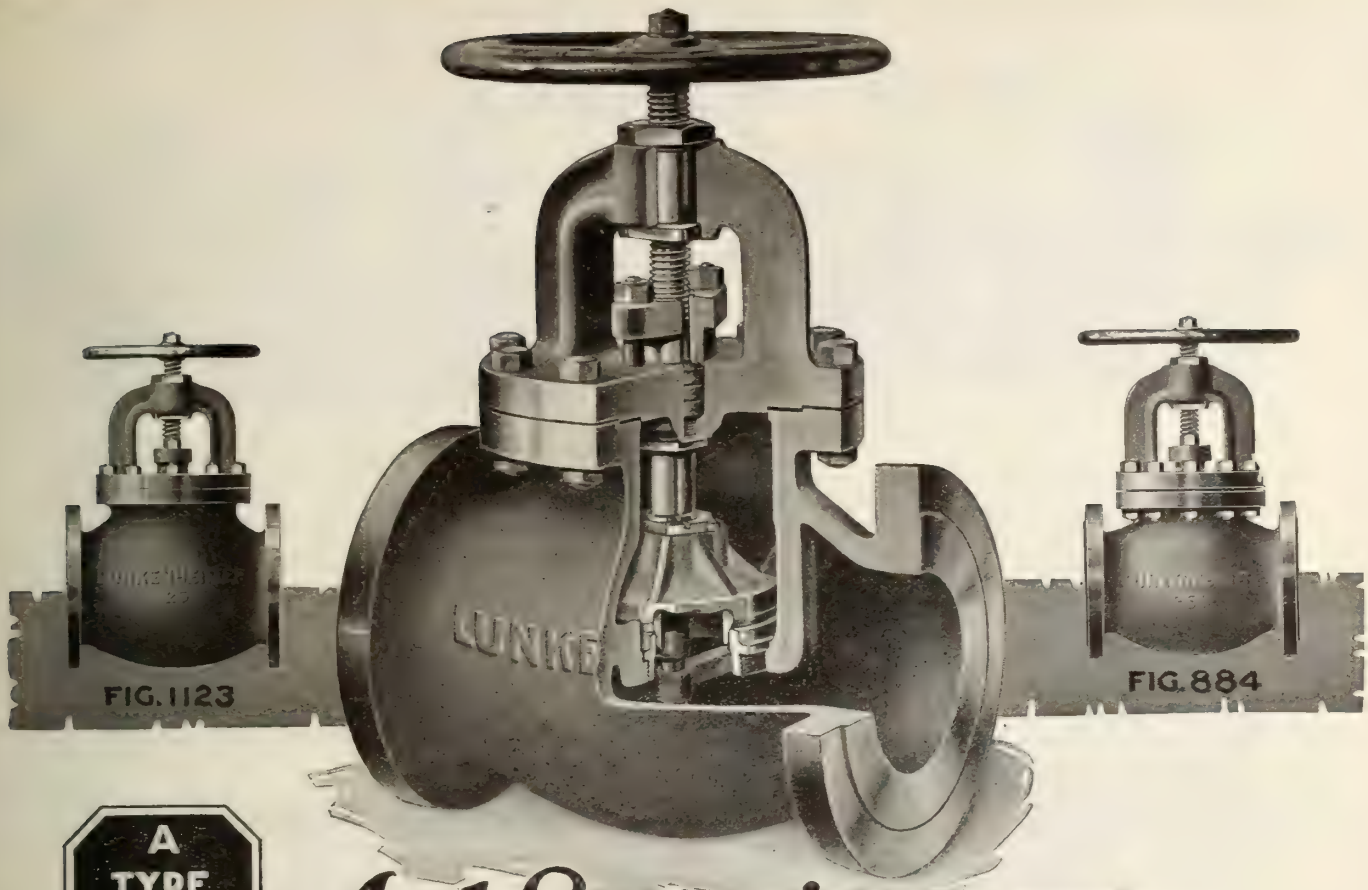

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And Service 'way beyond the average!

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With seating surfaces regrindable and all parts made to gauge and renewable, the installation of Lunkenheimer Valves means permanence in the line with a minimum expense for maintenance and repairs.

Our catalog No. 58-DC illustrates and describes the various types in detail. A copy will be sent on request. If you have a valve problem, we will help you—no obligation.

Fig. 606
Cast Steel

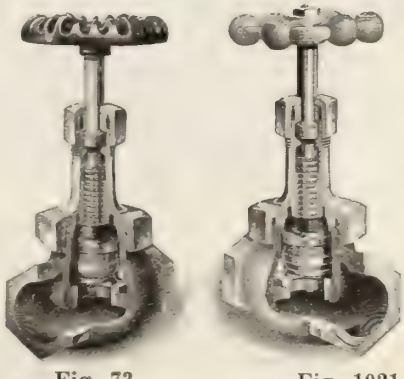

Fig. 73
"Renewo"

Fig. 1021
"Ferrenewo"

"America's Best since 1862"

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Coal is the least that a leaky steam trap wastes

By the time power gets up to your coils or machines as steam, it costs far more than at the coal pile, heat unit for heat unit. All along the line you are adding charges of firing, oiling, superintendence and overhead.

So to measure the loss from a leaky steam trap in tons of coal or units of power is not enough. This is a fact which drives home the importance of a steam trap worthy of the name.

"Just a ball—that's all!" A floating ball is the only moving part of the Johns-Manville Steam Trap. No valves, levers or thermostats to get out of order. And the action of this Trap, in preventing loss of steam and discharging air and water, is as sure as it is simple.

Why Johns-Manville Steam Traps do not leak

There is always, in a Johns-Manville Trap, a thin water seal between the steam and the outlet. Here is how this Trap works—and the extreme simplicity of its construction means that it always *does* work.

A hollow ball is the only moving part.

When the entering water raises the ball, the discharge orifice is exposed, and water and air flow out.

When the water level drops, the ball drops. It rolls over the discharge orifice, thus throttling down the outflow and maintaining sufficient water in the Trap to prevent steam leakage.

This action is sure. You can depend on the Johns-Manville Steam Trap to save power and so to help cut your operating costs.

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INSULATION *that keeps the heat where it belongs*
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LININGS *that make brakes safe*
FIRE PREVENTION PRODUCTS

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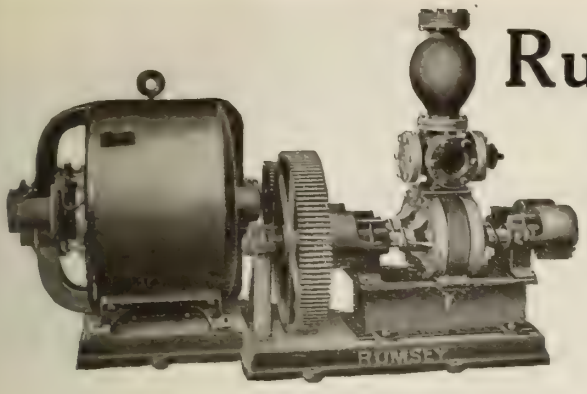
Power Plant Materials

Rumsey Pumps



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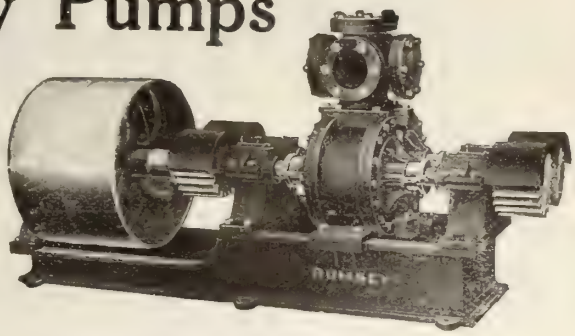

Rumsey Electric Rotary Fire Pump.
Designed for general service as well as fire duty; 100 pounds pressure for fire service, and 75 pounds pressure for general service is recommended.

RUMSEY Hand and Power Rotary Force Pumps will handle almost any liquid that will flow—water, oil, paint, varnish, gasoline, grease, tar, ink, extracts, sizes, soaps, chemicals and commercial liquids of all kinds—liquids of a gritty nature, or those that have a chemical action unsuitable to iron or bronze excepted. The compactness and convenience of Rumsey Rotary Pumps, their large capacity and low cost make them the preferred pump for all kinds of general pumping. Full information from

Rumsey Power Rotary Force Pump.
for elevation up to 170 feet and pressures up to 75 pounds. Designed for water supply, oils or special liquids and for general pumping in mills and factories wherever a moderate priced pump of large capacity is desired.

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EVERY DART UNION BEARS THIS MARK

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BRONE To BRONZE **Dart Union Co. Limited** AT THE JOINT
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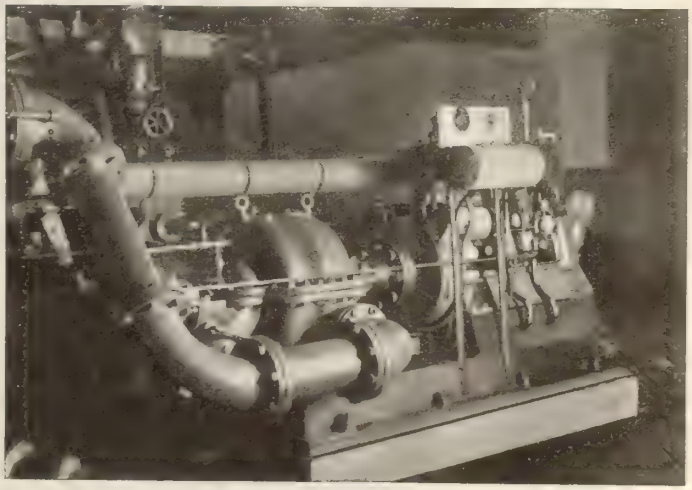
If You Have No Reserve Power, You Should be Interested in a Set Like This

The maintenance cost of fire in a steam reserve plant of equivalent h.p. would just about pay for a STERLING one year.



4-cylinder STERLING engine at Maywood, Illinois, on a Morris centrifugal pump handling 1,000 G.P.M. at a speed of 1,200 R.P.M. against 60 pounds pressure. Installed by Henion & Hubbel, Chicago, and used almost daily. Keeps down the power rate and assures standby power.

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12 ton, 300 H.P., 900 to 1,500 R.P.M.

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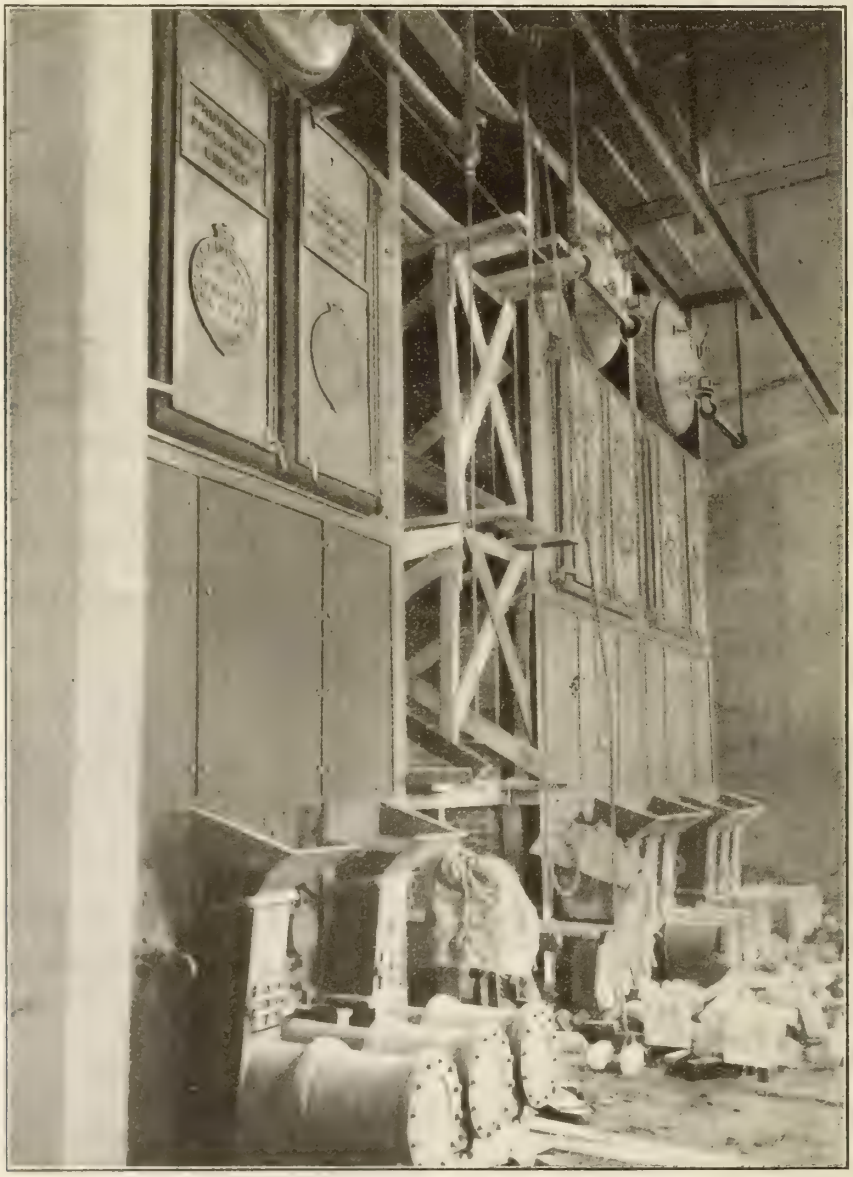
G. & McC. Sectional Water Tube Boilers



The Boiler Room of the Provincial Paper Mills at Mille Roches, Que., equipped with three G. & McC. Sectional Water Tube Boilers.

G. & McC. Boilers are designed and built to give more rapid circulation and increased steaming capacity.

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The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

The Provincial Paper Mills Power Plant

There Are 750 Rated Boiler Horse Power Installed so Far, and Future Developments Will be Cared for by Extending the Building. The Boiler Room and Its Appurtenances Are of An Interesting Character

By T. H. FENNER

THE LITTLE town of Mille Roches, Ont., has for the reason of its existence the paper mill of the Provincial Paper Co. and in order to maintain production at a normal rate, with moderate production costs, this mill has been furnished with a modern and complete steam power plant, to take the place of the original installation, which has done duty for a number of years.

The new plant is a fine example of design and workmanship, and was constructed to the plans and specifications of Mr. R. S. Kelsch, consulting engineer of Montreal.

The plant has been built with a view to further extension at some future date, and is so arranged that when this development occurs, the present plant will be a complete unit on one side of the stack, and the new unit will be sustained on the other, making a completely symmetrical arrangement. The fans, pumps, etc., are placed in the present boiler room about opposite the stack, so that when the plant is extended, these important units will occupy a central position. The overhead coal bunker, coal receiving grating, coal crusher, elevator and ash bunker, are also situated at one end of the present installation, so that in the future they will also be in the exact centre of the plant.

The Boiler Room

The boiler room consists of a brick building, one story with a basement, the roof being flat, and furnished with a monitor skylight, to carry off the radiated heat from the top of the boilers. In the basement, which is built entirely of concrete, are situated the outlets from the boiler ash pits, and in a separate enclosed apartment extending in front of the building, the coal crusher and coal elevator. In another entirely enclosed apartment in the basement, are the fan engines and the fan, the countershaft which drives the timing arrangement of the stokers being brought through the concrete wall to a position directly under the stokers, and a belt passes through the floor from each stoker timer to the countershaft.

On the boiler room floor are store rooms and wash rooms for the firemen, while directly in front of the base of the stack, is a further concrete totally enclosed room, which contains the feed pumps and heater. The arrangement is such that there is an almost entire absence of dust, even when the coal crusher and elevator is working, and the main boiler room and firing floor present an appearance of spaciousness which is somewhat surprising after observing the building from the outside.

The Boilers

The boilers at present installed consist of three Goldie & McCulloch water tube boilers of the usual longitudinal drum type. The drums are 54 inches in diameter, by 23 feet in length. Each boiler contains 2,636 square feet of heating surface, being rated at 250 horse power. Two of the units are arranged side by side, to form a battery and there is a space between them and the single boiler, permitting room for a passage between in which are arranged the smoke blower connections. Each drum is fitted with the usual combined feed stop and check valve, and two direct connected gauge glasses are fitted to the front of each drum. The blow-off valves from the mud drums are the "Yarway" type, made by the Yarnall Waring Co. and from the outlet of the valves pipes are led down into the basement and from there to a blow-off tank

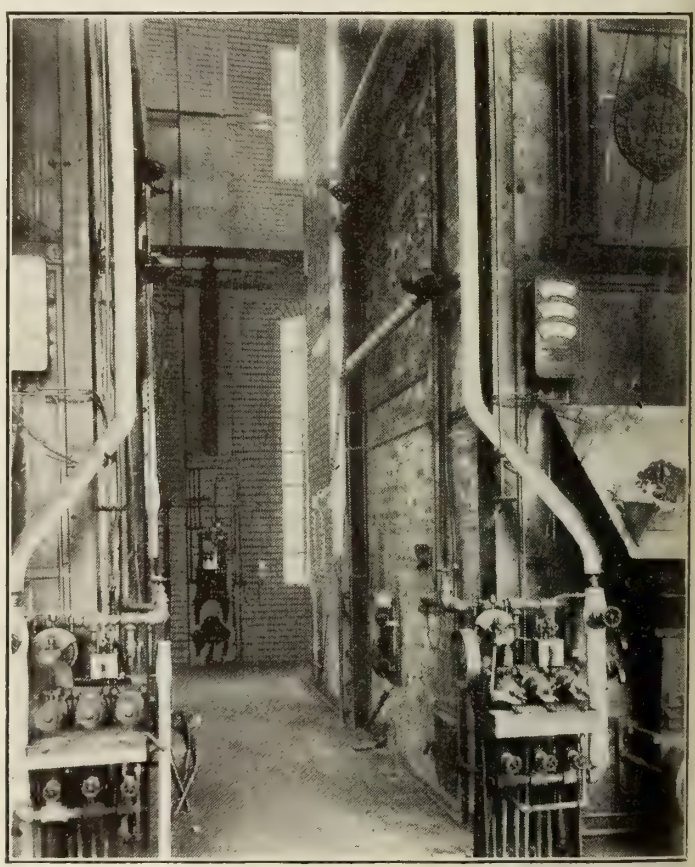
View of power house showing overhead bunker.

situated outside the building underground.

Each boiler is fitted with the Jones stoker, there being three retorts on each furnace, these stokers being made by the Underfeed Stoker Co. of Canada, the type used being the A. C. These stokers are operated by the Cole timing valve used by the Underfeed Stoker Co. the timing valve being operated from the fan engine shaft. The fan being controlled by the damper regulator, thus automatically slows down these stokers when it is itself slowed down by the damper regulator functioning.

The stokers have an area under each boiler of 6 feet by 9 feet in width. They are designed to give a rating of 200 per cent. for four hours, or a continuous rating of 150 per cent. On a basis of 13,000 B. T. U, per lb. of coal they are guaranteed to maintain an efficiency of 76 per cent. at 100 per cent. rating, 150 per cent. at 75 per cent. rating and 73 per cent. when operating at 200 per cent. rating. This is in accordance with the very best practice, and an efficiency of 75 per cent. at 75 per cent. rating is about as good as can be obtained under most conditions. Each boiler is fitted with a 5 unit valve-in-head Diamond [illegible].

Boiler fronts, stokers, weigh larry shoot, and ash conveyor riser in left foreground.



Looking between the boilers. Hay's CO2 Recorder and Draft Recorder on wall at back. The pipes on side wall are the Diamond Soot Blower connections. The three in one Precision Draft Gauge is seen just above coal hopper on boiler fronts, and the Cole timing valve for Jones Stoker is in foreground.

Recording and Indicating Instruments

Each boiler is fitted with a Precision Instrument Co. three point draft gauge. These instruments show at all times the draft over the fire, the air pressure in the tuyeres, and the draft in the last pass, or what is practically the chimney draft. Thus the fireman can tell at a glance just what the condition of the fire is, and any irregularity is detected as soon as it occurs. At the time of our visit the tuyeres pressure was showing 3.5 in. of water column, the draft over the fire was .1 while the chimney draft was about .6 inches of water.

There is also a Hay's CO_2 and draft recorder fitted on a pedestal at the back of the boilers right opposite the passage between No. 1 and 2 boilers. This is connected up so as to take reading from the last pass of all the boilers together, or can be shut off from any two, and concentrated on any one, for CO_2 readings. The same arrangement is made for the draft recording. In addition to these instruments the Bailey Meter Co. are installing a steam recording gauge.

The Steam Piping

There are two ways of reaching the top of the boilers, one by a stairway which is outside the dividing wall of the boiler room and pump chamber, the other by an iron ladder at the back of the boilers in the boiler room. The layout top of the boilers is one that is distinctly pleasing to the eye, and a model of compactness and efficiency. The installation of the steam piping was done by the Garth Company of Montreal, the expansion bends and main valves being supplied by the Crane Co. From the stop valve of each boiler a large diameter bend is brought over to the main header, which runs along the front of the boilers, an iron grating being installed which allows easy access to all valves and the boiler tops. The main header is supported on rollers, and is free to expand in either direction being anchored by the bends connecting it to the main valves. From one end of the header the main steam line is taken to the mill, and there is also a 5 inch main which goes down to the basement and in a tunnel over to the fire pump. From this five inch main a connection is taken near the boiler room floor, to supply steam to a Penberthy injector, which is installed as a standby feed. The pipe to the fire pump, which is a considerable distance from the boiler room, is carried in a special insulating and supporting conduit, supplied by the Rickwell Co., Cleveland, Ohio.

The photograph reproduced here will give the reader a very good idea of the piping arrangement, and he cannot help but be impressed by the neatness of it. The boiler tops are covered with Armstrong cork brick, and the piping covering is neatly finished off, pesenting a very smooth surface, with but little chance for dust to effect a lodgment. The monitor above the boilers in the roof can be adjusted to maintain a temperature sufficient to keep the boiler room comfortable in the hottest weather, while it can be closed altogether during the

winter months if so desired. The boiler tops are splendidly lighted by this arrangement, while the artificial lighting is effected by 100 watt lamps enclosed in special globes which act as reflectors and diffuse the light evenly. These lights are unusually good looking for a boiler room installation, and add a great deal to the general appearance.

The boiler tops in fact, enticed one to linger, instead of having the usual effect of hastening one's departing footsteps to a cooler and more pleasant region. Although two boilers were running the effectiveness of the insulation and ventilation was such that there was no inconvenience felt at all.

The Feed Arrangement

The feed arrangement consists of two Weir feed pumps and a Cochrane heater, in addition to the stand by injector already mentioned. The pumps and heater are situated in a recess at the end of the boiler room, right opposite the base of the stack, and the heater is placed on a concrete pier at a distance of about six feet above the suction of the feed pumps.

The pumps are each of 6 inch by 8½ inch by 15 inches in capacity, and are made in Canada by the J. & G. Weir Co. of Canada, Montreal, similar in every way to the pumps made by the parent company of Glasgow. Each pump is fitted with a counter by which the number of strokes can be checked up per hour, day, week or any other time required. They deliver the water to a main feed header running along the front of the boilers, from which a branch is taken off to each drum. Air vessels are fitted at the top of the delivery pipes which effectively cushion the pulsations of the pumps and give a steady smooth delivery.

The heater is of the Cochrane type, made by the Canadian Allis Chalmers with a heating capacity of 53,000 lbs. water per hour. It is supplied with a V notch, weir meter capable of handling 60,000 lbs. of water per hour. In connection with this meter there is an integrating, indicating and graphic meter for giving records and instantaneous reading of the amount of water being passed through the heater. The exhaust pipe leading to the heater is of 14 inches diameter, and is fitted with an oil separator, capable of purifying 185 lbs. steam per minute. The total water capacity of the heater is 115 cubic feet. The main suction of the pumps is 5 inches, and this is branched off to each pump.

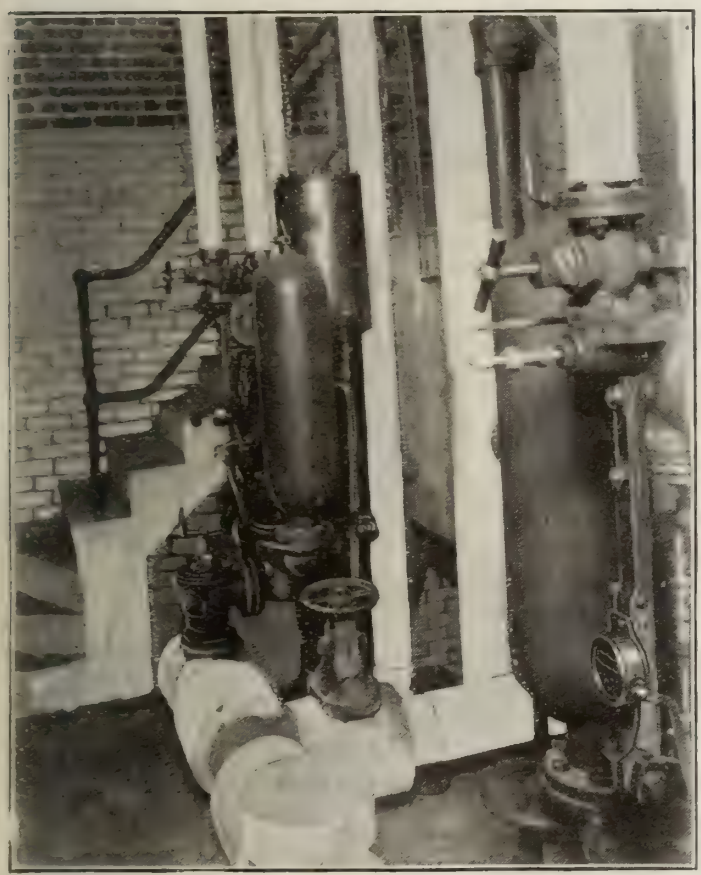
For use when the main heater is being cleaned there is a stand by hot well situated in the same recess and just alongside the main heater. This is of small capacity as it will only be needed at infrequent intervals, and at a time when the plant would be shut down.

This pump and heater room is closed off from the main boiler room by two doors, and when these are kept closed, the whole place is practically dust proof. It is lighted by side windows which can be opened for ventilation purposes when required. The fan engines and fans are just below, and can be reached by a ladder running from a grating back of the heater, the fan room in its turn being closed off from the main basement. The general effect is that the pumps, heater and fans are enclosed in a two storey concrete room, separated from the rest of the boiler room, and reached through well fitting doors.

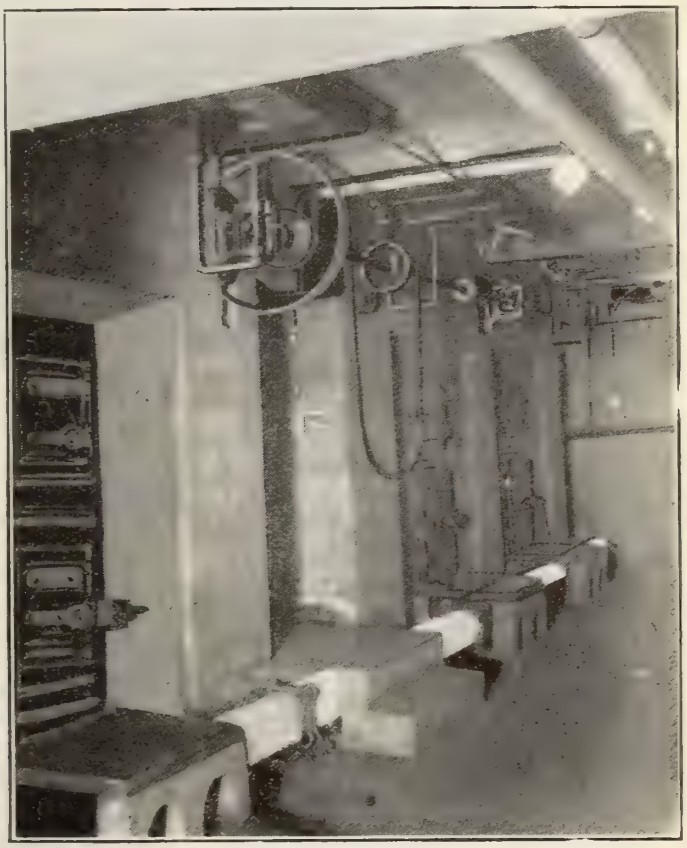
The Fan Arrangement

The air combustion is supplied by Sturtevant fan, driven by one of two engines, which can be connected to the fan shaft by means of flexible couplings, one engine being on each side of the fan. The fan is 160 inches diameter and the engines are 9 x 8 vertical high speed self oiling enclosed type. The fan delivers 33,000 cubic feet of air per minute at a static pressure of 5 inches water column.

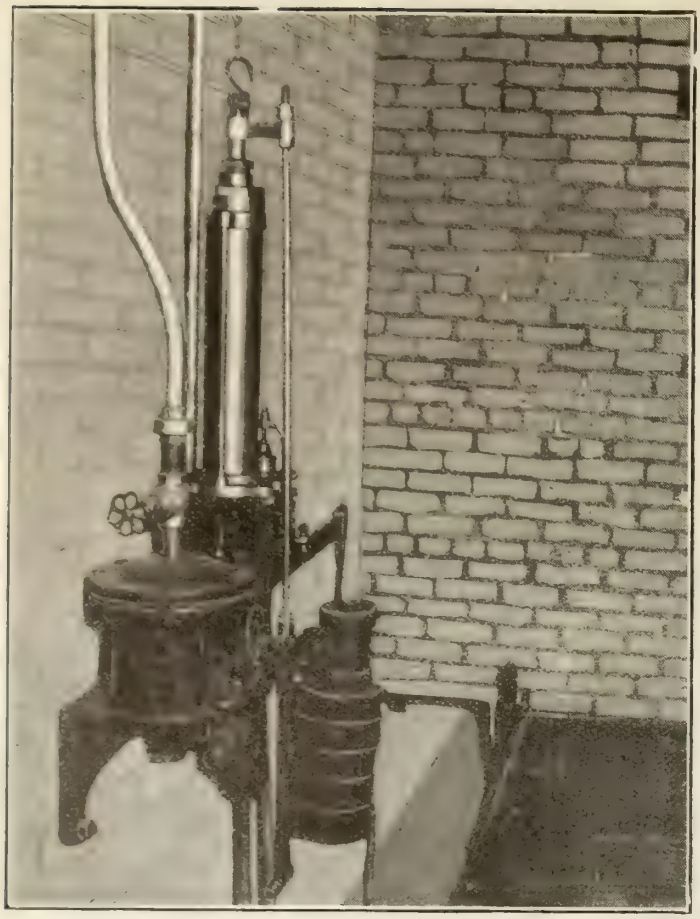
The fan engines are controlled by a Ruggles Klingemann automatic damper regulator, which is set to operate at a point just below the blow off pressure of the boilers, 125 lbs. The damper regulator is very sensitive, and effectually controls the pressure within the range of about 4 lbs. per square inch. The damper operates a valve in the steam supply to the engine, closing it down when the pressure approaches the point set for. The slowing down of the fan engine diminishes the supply of air to the stokers and as the timing valves are driven from the fan engine shaft, it also slows down the timers stopping the supply of coal and the supply of air at the same time. The damper regulator is set on the chimney wall, at the back of the feed heater,



Part of pump room and Weir Feed Pumps. The steps lead up to the heater platform.



Basement showing ashpit doors and ash conveyor piping. The countershaft driving the stoker timers up above the floor.



The Ruggles-Klingemann Damper Regulator. The grating is just above fan engines.

in the same room with the pumps.

Coal Handling Equipment

The power house is situated on a railway siding, so that the cars can run right up over the grating through which the coal is dumped. This grating is 12 inches mesh. and directly underneath it is the track hopper, which in turn leads to a reciprocating feeder, which delivers the coal to the crusher. This crusher is of the two roll type, 23 by 24 inches, and it crushes the coal to a suitable size for the stokers.

Leading from the crusher there is a bucket elevator conveyor, 10 inches by 6 inches having 62 feet centres which communicate with the overhead bunker and shoots to the travelling weight hopper. Thus the coal can be delivered into the daily service bunker until that is full, when it spills over a partition into the reserve bunker. From this reserve it can be dropped down a shute into the ascending leg of the elevator conveyor, and once more fed into the service bunker when required. The coal handling machinery is all electrically driven.

From the bunkers are chutes which communicate with a 1,000 lb. travelling weighing hopper, which in turn delivers the particular stoker hopper which requires it.

The whole installation of the coal handling machinery is by the Canadian Link Belt Co.

Ash Handling

For the ash handling in the boiler room basement, there is a steam conveyor or ash ejector installed by the Green Economiser Co. There are at present three intakes, one for each boiler installed, and these are situated at the mouth of the sloping ashpit in the basement. The conveyor pipe goes up at the end of the building, and discharges the ashes into a receptacle built in the same concrete tower that carries the reserve and service bunker. From this ash bunker chutes extend over the track, so that cars can be backed under them and loaded direct.

The operation of the whole boiler room is thus practically automatic. The coal conveyor can handle 20 tons of coal per hour, and the ash conveyor when in use can dispose of 200 lbs. of ash per minute, when the nozzle is supplied with steam at 110 lbs. per square inch. One man can very comfortably look after the whole outfit.

The plant is decidedly well laid out, and we cannot help but think that a man would be bound to take a pride in having such a job in his care.

The old power house of the mill, situated a few yards away, forms a very effective contrast, and should make the comfort of the present plant very apparent to anyone who was familiar with both of them.

The Erecting Engineer

The erection of the plant has been supervised for Mr. R. S. Kelsch by Mr. H. Piers. Mr. Piers has had an interesting career and is very much in earnest over his present occupation, and takes a pride in the plant which grows up under his skilled direction.

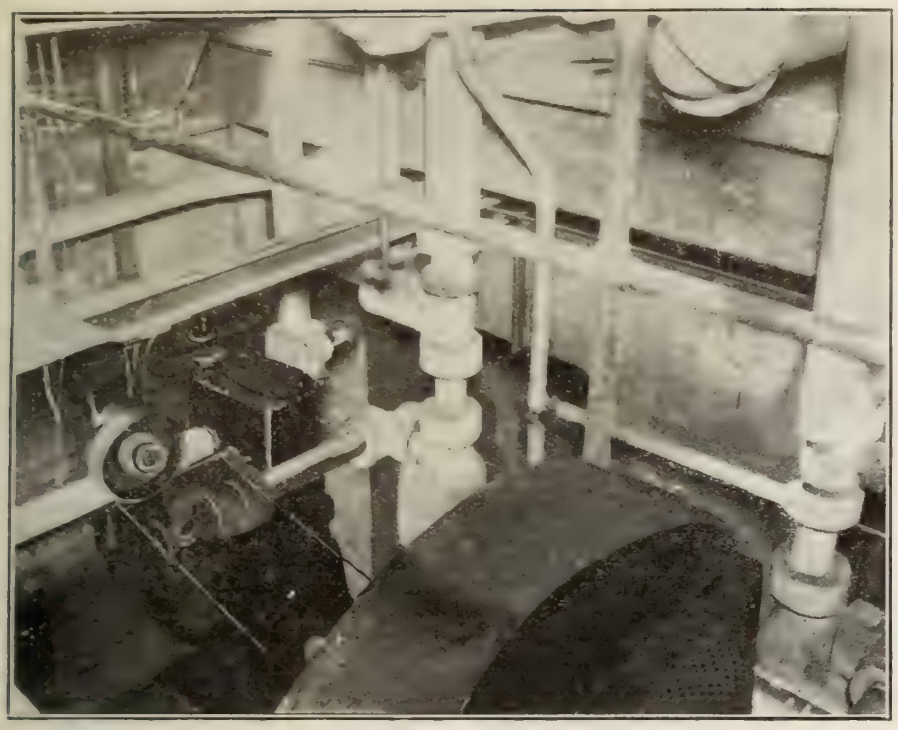
Mr. Piers was born in London, England, and educated at Kings College in that city. He served his apprenticeship with the firm of Humphrey, Tennant & Co., Deptford, and after his apprenticeship went to sea and sailed for a period of about nine years, obtaining the Board of Trade certificate of first class.

Leaving the sea he was employed on the superintending of new work for the British Government on the Tyne and Clyde, and continued at that work until coming to Canada.

Since that time Mr. Piers has been with Mr. Kelsch as supervising engineer of construction. His duties are to look after the carrying out of the specifications by the contractors, and when all is completed to his satisfaction, he starts up the plant, and gets it into thorough working order before handing it over to the owner's engineer.

It is a position that requires sound engineering and mechanical knowledge coupled with a considerable amount of

Partial view of Cochrane heater, showing the water meter.



Looking down on fan and fan engines. The grating was removed to obtain this view.

tact. Mr. Piers possesses these qualifications in marked degree, and we are indebted to him for the opportunity to thoroughly observe this plant for the benefit of our readers.

A STEAM TURBINE LOCOMOTIVE

Ever since the steam turbine—which was invented by Sir Charles Parsons in Great Britain—proved its wonderful advantage on board ship and for electric power generation, railway engineers have been looking forward to the possibility of applying it to locomotives. A bold experiment was recently made by a leading British locomotive factory, which constructed a turbo-electric locomotive, now being tested on the rail. The main turbine on this locomotive drives an electric generator which supplies power to four motors arranged in two groups on the front and the rear respectively of the locomotive. Each of these motors is capable of developing 275 horse power. One of the novel features of this locomotive is the condenser, in which the steam tubes revolve in water at a slow speed. The makers claim that this locomotive gives considerable saving in both fuel and water compared with the existing types.

View on boiler tops, showing main expansion bends. The bends at far end are on the feed pump steam pipes.

A 500 HORSE POWER ELECTRIC BOILER

To many people it will seem absurd to use electricity for making steam; but this is actually being done—and for a very good reason—on British railways. The railway systems in Great Britain are gradually being electrified where the conditions are favourable; and the result is that on certain routes steam haulage will be at work on one portion and electric haulage on another. The usual practice is to heat steam trains with the steam from the locomotive, and obviously this method cannot be continued when the steam locomotives are replaced by electric locomotives. Experiments have therefore been made with boilers heated by electricity, and tests made with one of 50 horse power have been remarkably successful. The efficiency of this system of heating is very high and the life of the elements is, owing to skilful design, very long. Plans are now being got out for a 500 horse power boiler, large enough to maintain the steam supply for a full size main line train.

SAFETY DEVICE FOR ELECTRIC HEATERS

One of the drawbacks of electrical appliances for heating water and other liquids is that if by chance the current is switched on while the utensil, such as a kettle or urn, is empty, the element gets overheated and is apt to burn out. In order to get over this difficulty some makers introduced a safety device in the form of a metal plug which melts at a comparatively low temperature and breaks the circuit, thus preventing overheating of the element. This method works fairly well but it has the objection that in order to bring the utensil into action again a new plug must be inserted. A British firm has therefore devised a safety appliance which is equally effective in action but which does not involve any part requiring replacement. It consists of a simple mechanical arrangement which cuts off the current when the utensil boils dry. All that is necessary to restore connection is to fill the utensil with water, when the device automatically re-sets itself.

Engineering Equipment Co., Limited, with offices at 619-23 New Birks Bldg., Montreal, have recently been appointed exclusive Canadian sales representatives for Schutte & Koerting Company of Philadelphia, manufacturers of the Koerting Low Lever Jet Condenser and a very complete line of power plant equipment.

The business is handled by four departments: Valve, Marine, Condenser and Jet and Chemical Department.

The University of Illinois Engineering Experiment Station, have issued bulletin No. 128, dealing with the ignition temperature of coal, the investigation being conducted by Ray W. Arms.

At the Bottom of the Temperature Scale

A Glimpse Into the Realm of Prodigiously Low Temperature Where Mercury Freezes to Stone and Ice is at a Fervent Heat

By RAYMOND FRANCIS YATES
(In "Tycos," Rochester)

THE VISITOR to the low temperature laboratory is shown a double-walled vessel containing a pale blue liquid seemingly impotent and harmless. Great mystery lurks within its limpid depths. It is boiling quietly, yet its temperature is several hundred degrees below that of the barren ice fields of the frozen North. This blue-tinted substance is liquid air. Its temperature is many, many degrees below the zero mark on a Tycos thermometer. When Fahrenheit put the zero mark on his temperature scale, little did he realize that it was several hundred degrees above the lowest temperature that would be produced by man. These wonderful facts concerning this apparently harmless liquid are interesting. Let us learn about it.

To the man who is not able to reason in scientific terms, the attainment of a temperature that reaches as far as 400 degrees Fahrenheit below zero is a seeming impossibility. These prodigiously low temperatures are produced every day in laboratories all over the world, and the method has been so simplified and perfected that it is a commercial reality which lost its speculative nature some time ago. The mere thought of a temperature as low as 400 degrees below zero is enough to stagger the imagination of the everyday man, yet the facts concerning the production of these low temperatures are easily understood.

Early in his career, Lord Kelvin discovered that if a gas was compressed and then allowed to expand freely through a small orifice, its temperature was lowered to a very noticeable extent. We can prove this by means of a very simple experiment, as all we have to do is whistle. When we do this, we compress the air within our cheeks and then allow it to expand through our puckered lips. If we place our hand close to our mouth, we can feel that the air issuing is quite cool, although it is hot when it leaves our mouth. If we could take that air which came through our puckered lips and put it through the same process again, we would find that it would become still colder. While it would be impossible for us to do this, machines have been devised that will do it and liquid air is produced to-day in large quantities by a machine that puts it through a continued process of alternate compression and expansion until it becomes so cold that it freezes to a liquid. In fact, if it is carried far enough, the air will not only be produced in the liquid state, but it will freeze to a white solid. The principle of producing liquid air by the "self-intensifying" process is easily understood. The air is first compressed to many thousand pounds to the square inch and then allowed to expand through an orifice. This expansion causes the expanding air to become colder, and this cooled air is circulated around the pipe bringing the compressed air. The compressed air is thus delivered at the orifice in a cooled condition. It then expands, causing further cooling, and this further cooled air in turn circulates around the compressed air pipe, making it still colder. The compressed air is thus continually becoming colder; the expansion produces more cold and by repeating this cycle uninterrupted, the temperature can soon be lowered so far that the expanding air becomes liquid.

Now that we have obtained an elementary understanding of the method of producing low temperatures, we will learn just what a wonderful thing a gas is when reduced to the liquid state. We are all acquainted with the fact that there are three distinct states of matter: solid, liquid and gaseous. We are also familiar with the fact that certain substances are easily changed from one state to another by simple means. Water, in its natural state and at normal temperature, is a liquid, but if we expose it to a temperature below the zero mark on a Tycos thermometer it rapidly becomes a solid and if we apply heat to it until it reaches a temperature of 212 Fahr. it becomes vaporous or gaseous. If we cool steam, it will immediately return to the liquid state, and this is true of any gas: if it is cooled it condenses and comes to the liquid state. Its tiny ultimate parts, which we are pleased to call molecules, crowd closer and closer together, depending on how much the temperature is lowered. If it is lowered enough, the molecules crowd so closely that they form a liquid and, if we have means to further reduce the temperature, they will crowd so close that a solid will be produced. Take oxygen, for example. Nature decrees that oxygen shall be a gaseous substance, but to be a gaseous substance it must have a specific temperature. If this temperature is either made higher or lower, the gas tends to expand or contract as the case may be. If we liquefy oxygen, we will have a very difficult time keeping it in its liquid state, since nature is constantly calling it back, it must have a certain amount of heat and this it subtracts greedily from its surroundings, leaving them comparatively heatless. Oxygen, when in the liquid state, is continuously boiling and vaporizing since it robs heat from everything with which it comes in contact, until it receives enough to return to its original state, a gas.

Now that we have come to understand just how low temperatures are produced, and the nature of liquid gases, there will probably be one dominating question in our minds, and that will be: "What will these liquid gases do; how will they affect other matter and what is their general behaviour?" This question opens the realm of romance in the study of low temperatures and liquid gases, since they perform many astonishing feats that are far removed from the common events of our everyday life.

If we drop a little water into a vessel of, say, liquid nitrogen, the water is instantly changed to ice and rattles around merrily in the nitrogen for a few seconds, since the nitrogen boils furiously when the water reaches it. This boiling continues until every bit of available heat is subtracted from the water or ice and then all remains quiet within the pale blue depths. In fact, if we dropped a piece of ice within the liquid, it would cause it to boil rapidly in the same manner! This fact causes no little wonderment in the minds of the layman, but it is easily understood. In the liquid gas we have a temperature several hundred degrees below zero, while the ice is just a little below zero, which, in comparison to the liquid gas, is warm; hot, in fact. From this it is also interesting to note that there is no such thing as cold. When we say that a substance is cold, we really mean that it contains only a small amount of heat. If a substance had absolutely no heat, the scientist would say that it was at "absolute zero." However, this goal has never been attained, although it has been approached within three degrees.

In our next experiment with liquid gases, we will drop a few elastic bands into a vessel of liquid air, and after the air has completed its period of boiling (it boils at 193 degrees Centigrade below zero), we will take the rubber bands out and examine them. We are quite surprised to see that they are frozen stiff, and if they were of the proper color, they would resemble macaroni that was in an extra dry condition. In fact, the rubber bands will be found to be very dry after they are removed from the liquid as it vaporizes as soon as it comes in contact with the outside air.

Our rubber bands, instead of being soft and flexible, are hard and brittle and will snap and crack if we apply pressure to them.

If a little liquid air is thrown upon the floor, there will be nothing left to mark the spot it struck but a little puff of white frost that rises and quickly disappears. If we examine the floor (no matter how quickly after the liquid strikes it) we will find that it is perfectly dry.

There are many more interesting experiments in freezing that can be performed with liquid air. If some of the substance is placed in a tin cup and the cup is covered up and connected to a vacuum pump, the liquid air will be evaporated so rapidly that the temperature of that which remains behind will be still further lowered, and, if the operation is continued long enough, we will find that a white solid substance will form on the outside of the tin cup. We might satisfy ourselves by assuming that it is moisture from the atmosphere freezing to the sides of the cup. True, some of it is moisture, but a large part of it is air which has been frozen to a solid mass! After all the air in the tin cup is vaporized, we will drop the cup on the floor or strike it a sharp blow with a hammer. To our surprise the cup will break exactly like a fragile piece of china. The explanation is that the cup became frozen and was rendered so brittle that it broke. The idea of freezing a piece of metal may seem rather remarkable to some people, but it is nevertheless true.

What would happen if we were to immerse our finger in liquid air? This is a very natural, as well as interesting, question. If we immersed our finger for the fractional part of a second, no harm would come of it, since the heat of the finger would cause the air to boil so furiously that it would not come in actual contact with it. If we left our finger in it until it got cold enough, and the liquid air actually came in contact with it, we could break our finger off much as if it were made of china. Would the finger return to its normal state? The answer is yes, from the standpoint of temperature and degree of hardness, but we would find that the finger would be absolutely lifeless from there on and would have to be amputated.

If a little mercury, similar to that used in Tycos thermometers, is dropped into liquid air, it may afterwards be used as a hammer, as it is frozen so hard that it will not lose its shape or be scratched. Flowers and all kinds of vegetation act in the same manner; they are frozen to a brittle solid.

If a bell were made of lead and immersed in liquid air, it would ring when taken out, much in the same manner as a bell made of brass.

What would happen if we were to drop a burning match into the liquid air? This question may appear absurd to the layman at first thought, but is it? Let us consider for a moment. We were taught back at school that oxygen causes things to burn. It supports combustion to put it chemically. We know then that we must have a considerable percentage of oxygen in our liquid air as the atmosphere contains a great volume of it. The question is, will the oxygen still support combustion when at this extremely low temperature? The answer is yes, very energetically. Instead of the match going out in the liquid air, we would find it to burn with almost explosive violence. Many materials and substances that will not burn in the atmosphere will do so in liquid air.

For the past few years scientists have been trying to reach the ultimate goal in low temperature work, and this goal, as previously stated, is what is known as "absolute zero." This has been calculated to be 273 degrees Centigrade below zero. A greater degree of cold cannot be obtained.

TESTING PETROLEUM PRODUCTS

The issuance of technical paper 298, "Methods for testing petroleum products, adopted by the Interdepartmental Petroleum Specifications Committee," is announced by the Bureau of Mines.

The methods included in this handbook are used officially in the routine testing and inspection of petroleum products bought under Federal specifications. They supersede similar methods published in Bulletins 1 to 5, inclusive, of the Committee on Standardization of Petroleum Specifications.

The Interdepartmental Petroleum Specifications Committee was formed under authority of the Bureau of the Budget, dated October 10, 1921, and an Executive Order, dated November 8, 1921. It replaced the Interdepartmental Committee on Standardization of Petroleum Specifications, which in turn superseded the war-time Committee on Standardization of Petroleum Specifications. The work of the several committees has been continuous, and the present set of testing methods is the result of several years' experience in preparing specifications and drawing up testing methods for petroleum products.

The present set of testing methods was prepared by the Technical Committee on Standardization of Petroleum Specifications and adopted by the Interdepartmental Committee on Standardization of Petroleum Specifications, which were the immediate predecessors of the present committee.

The paper includes information regarding color tests; cloud and pour point determinations; viscosity tests for fuel and lubricating oils; melting of paraffin wax, distillation of gasoline and kerosene; flash point determination; burning tests for kerosene; long-time burning oil, mineral seal oil and signal oil; determination of water; emulsion tests; determination of sulphur; the doctor test; corrosion tests, etc., etc.

Technical paper 298 may be obtained from the Bureau of Mines, Washington, D.C., one copy being distributed free of charge to an applicant. The paper is obtainable in quantity lots from the Superintendent of Documents, Washington, D.C., at 10 cents per copy.

THE POWER EXPOSITION

Announcement has been made of the National Exposition of Power and Mechanical Engineering to be held at the Grand Central Palace, New York, from December 7 to 13, inclusive, (except Sunday intervening) by the managers of the Exposition.

The Exposition was decided upon by a group of engineers and manufacturers who had felt the need for such a means of having men get together, exchange ideas, see the latest development in equipment, and lay problems before the manufacturer.

The business opportunity where a manufacturer may meet a large assemblage of power plant and mechanical engineers and capitalists interested in power, is significant to firms keen for such business. A number of progressive manufacturers have already engaged space for their exhibits.

The Exposition will immediately follow the annual meeting of the American Society of Mechanical Engineers and it is expected that the exhibits will supplement the programs and discussions at the professional meetings of the Society. The Professional Divisions of the Society will hold sessions relating to fuels, stokers, steam power plants, railroads, steam utilization in the paper industry, textile and gas power, and it is expected that the exhibits at the Exposition will throw interesting light on the papers presented at these sessions of the A.S.M.E. meeting.

That the Exposition will be comprehensive may be inferred from the plans which are to include exhibits of every type of machine, apparatus, equipment, instrument, device and the various materials and supplies necessary in the operation of the complete power plant. The committee decided that its keynote should be "an Exposition of apparatus employed in the generation, distribution and utilization of power."

The advisory committee for the Exposition, under the chairmanship of I. E. Moultrop, of the Edison Electric Illuminating Company of Boston, is comprised of: Milan R. Bump, president National Electric Light Association; N. A. Carle, vice-president and general manager Public Service Production Company; A. G. Christie, professor mechanical engineering, Johns-Hopkins University; Fred Felderman, national vice-president, National Assn. of Stationary Engineers; E. B. Katte, chief engineer, motive power, N.Y.C.R.R.; Dexter S. Kimball, president, The American Society of Mechanical Engineers; Fred R. Low, editor "Power"; David Moffat Myers, of Griggs and Myers, Consulting Engineers; Calvin W. Rice, secretary, The American Society of Mechanical Engineers; and the managers are Charles F. Roth and Fred W. Payne, with offices in Grand Central Palace, New York, to which all requests for fuller information and reservation of space should be made.

Bulletin 73 of the Kwanee Boiler Company, Kewanee, Ill., describes their Kewanee horizontal return tube boiler for power purposes, and also their Kewanee smokeless tubular boiler with down draft furnace and steel casing. Complete specifications and particulars are included in the bulletin, and also the Century rocking grates.

The Staff Have A Discussion on Combustion

How to Get the Best Results From a Mixture of Wood and Coal Was the Point—See How These Practical Men Present Their Arguments

By "JOHNNY SHOVEL"

This is the first of a series of articles on the practical operation of boilers by a man well qualified to speak on the subject. He is writing them in plain language, and avoiding technicalities. There will be a fund of information found in these articles for all classes of engineers.

IN THE days when we were young it was the usual thing among families of modest means to send boys who "liked machinery," to learn a trade. After the ordinary school, that was all the education the "old man" could afford to give us, and when we started in, we worked for experience and darned little else.

But that was better than my dad had it. His father had to "pay a premium" to get him apprenticed. That is, he gave the firm to which my dad was bound, fifty dollars to start him in, in their shops. I don't remember whether the fifty covered it all or had to be paid yearly. I do know that in my time, apprentices worked the first six months without pay, and for six months after drew the useful sum of $2.50 per week. Very different from the present day.

My own particular tastes brought me under the dominion of the master mechanic of a ramshackle plant in which railroad cars were built, and there is not the least shadow of a doubt that in his gang we got experience all right.

We were a helper. We helped the belt man fix belts and the oiler to oil. We gave a hand to put up shafting, and we helped make foundations and afterwards to put the machines on them. For the electrician we crawled around on the roof timbers of the foundry, said timbers being particularly well loaded with dust, so that we got almost stifled with it in combination with the grease and wood smoke from the moulding floor below.

That company had grown and overgrown and its shops had been put up helter-skelter, any old how, whenever they had need of a new one. There were six engine rooms, each with a man in charge, besides fan engines and a hoist or two. We had five boiler rooms scattered around the plant to make the necessary steam. Every time a man "took a day" the gang would be juggled around to keep things going, and we would be sent to fill in according to our ability.

Being "willing" we got a chance to try our hand at a number of things.

Some days (they seemed years) we fired at the mill, where there were four big R.T. boilers. The mixture was shavings, sawdust, and when necessity compelled, a little soft coal slack to keep her going. The shavings were handled by a blower. But for some reason or other, they were not fed straight into the furnaces. They dropped into a brick compartment at one end of the boiler room, and from there we had to shovel them to a pile in the middle of the floor, and then shovel them again into the furnaces.

Under the conditions, firing one of those boilers was like feeding an elephant with strawberries, strenuous work for the results. The company had such a time keeping men on the job, they simply had to think about making changes. A great many schemes were discussed and the advantages and drawbacks to each kind of furnace well considered.

He Liked Dutch Ovens

The engineer at the mill favored "Dutch ovens," and he used to tell us what a soft time the firemen would have when he got one built in front of each boiler. "The stuff that comes in to us is about half water," he said, "that has to be dried out before it will burn. Now the roof of a "Dutch oven" can be made hot by firing good dry stuff for a while. Then when it's good and hot, you can start giving her the stuff as it comes. You have 'perpetual motion' just as long as you keep the supply somewhere under the drying ability of the roof, because the heat from the roof dries the wood, and heat from the burning wood keeps the roof hot, so there is more heat to dry the next lot of stuff that comes along! When you are firing this stuff you got to have plenty of room, so we will make them good and big, and put in big grates, because there 'aint much heat in the stuff we get. Most of the time you have to handle more than two ton of it for the same quantity of heat we could get out of a ton of coal, if they would give it to us.

"The grates will be slantin' to the boiler, so the shavings and sawdust must roll down the incline and will not be able to gather in heaps, same as they do on us in these blamed little furnaces. You know what happens if you work hard and get a pile under one of these boilers. Only the outside will burn, 'cause that's the only part that gets any air. On the inclined grates, the stuff will not get too thick at any one point, and the air will get through the bars easy. With these grates, and the stuff coming in through the chutes straight through the roof of the furnace, the outfit will be self-feeding. No more back-breaking shoveling when we get our "Dutch ovens'."

A Counter Opinion

The engineer at the blacksmith shop was skeptical. "When you get those big furnaces in your boiler house, you have very little room to work them, much less repair them," was his verdict. "Sometimes you have to fire with coal, 'cause there is not enough stuff coming in from the mill to keep you going. Then, my lad, you will find that those wonderful big grates of yours are mighty hard to keep covered. Unless you are darned careful, you will get too big a fire or a bunch of holes. They cost money to build, those 'Dutch ovens'. The roof arch

is so wide that it exerts a tremendous pressure on the bricks which are in it, and unless they are the very best they are likely to spill off when the temperature is high, so the roof soon falls. You got to get bricks which will stand pressure at temperature and then put plenty of 'buckstays' on the sides so the walls will not bulge out and drop the roof into the furnace. A saw mill can use them and get satisfaction, 'cause they always have the same kind of fuel. You have to burn coal sometimes and you want a furnace which will burn shavings or coal, or a mixture of both, with equal success.

"A little more combustion space under your present boilers will do the trick. The best way you can use your brick is in building a higher setting. While at that you can extend the front far enough to get the chutes to discharge straight into the furnace. Then you are ready for any fuel."

What Joe Thought

Joe Le Blanc at "the factory," was burning shavings and sawdust, but the stuff that came to Joe was from wood that had at least been air-dried and most of it kiln-dried, and it was burned under Babcock and Wilcox boilers.

"Wid dese B. & W. boiler de shavin' from dis factory she is burn easy. Dar is plenty space between de gratebar an de tube. You boiler she set down so close to dose grate dar is no room for burn, no place for what you call combustion. De flam is long when wood is burn, and if you let him hit de cold boiler plate he is put out and an' do not make de big heat. You mus' be careful.

"My boiler, she is set twice more high dan you boiler. De shavin' have a long draw, so long, be gosh, dey 'aint hit dose grate at all. Look at dem. De front is bare, hardly nothing on dem, 'cept at de bridgewall. All burn while dey in de air, so plenty air for first class combustion. Plenty air is de whole business for if de fireman is feed too fast, at first de pressure go up, and den when de shavin' begin to pile, go down 'cause de air can't get thro' de pile an' only de outside is burn. You watch dat firemans, every time de steam go up a little he is cut off de stuff.

"Before dis job I was engineer, me, for a factory where dey make de house trim, flooring, sash an' door an' all dat kind of thing. We make de 'Dutch oven' in dat place, but we also take dem down ourself, too. Dey burn too much. All de shavin' an' some coal. Dats de first place I try dis plan. An you see dar is no coal burn here. In de winter tam all de surplus shavin' fall in de corner for de night fireman, who fire by hand."

The "cyclone" at Joe's place of toil was arranged to discharge into a big galvanized tank. The usual thing these days. This tank was directly above the boiler room and the chutes carried the stuff straight to the boilers, or, when the supply exceeded the demand, to a large brick room where it was stored against a time of need. In that store room he had a pipe from the blower, and all they had to do when they wanted stuff from there, was to get in and feed it to that pipe and let the blower shove it up into the gal. tank again. There was also a door in the "corner" through which the fireman could shovel the stuff, and by that door the night man in winter got his because the blower didn't run at night.

It cost something to build according to the requirements of the insurance company, but Joe's store room with its thick walls enabled him to save so many shavings when there were plenty being made, that he didn't have to burn any coal at all.

"What kind of grate? Well, I try everywhere to get some grate to suit dis stuff. Nobody have dem, what I want, wid holes taper, big underneath, and half de size inside de furnace. So I get me a nice piece of white pine, and have feller in de shop shape it. While he do dat, de blacksmit' is making me a special drill taper, for de taper holes. My idea is to have de air travel fast tro de holes and pass well into de fuel. De small stream will pass furder 'cause it's fast, and hole of dat shape hard to block, 'cause the air so fast it blow de shavin' out, or else dey fall tro de taper hole."

Some of the boys who visited Joe were used to firing coal only, and they found it hard to believe his theory of the partly bare grates. Joe explained that while he went to all kinds of trouble to get the air through his bars, really very little came through where the stuff was actually piled on them hardly more than enough to keep them from burning. Therefore the air for combustion must come from the front and since the supply through the firedoors was not enough, he arranged his chutes so the stuff would fall well towards the bridgewall and leave part of the grates uncovered, so the required air could get in. He didn't allow the shavings to blow into the furnace because the blast would burn up the grates. They dropped by gravity, and he could control the supply of air by the ash doors.

A CORRECTION

The article in May 5th issue, entitled "Boiler Explosion at Bridgeport," was wrongly credited to the "Traveler's Standard," instead of the "Locomotive."

BULLETIN

The Crane Packing Co., 1800 Cuyler Avenue, Chicago, have published a very interesting little book on the metallic packing of condensers. While the book is frankly intended to advertise the packing made by the firm publishing the book, it contains a good deal of interesting information on condenser tubes not generally available. There is a short article on condenser tube disintegration, with illustrations, one on condenser tube deformation, also illustrated, and two microscopic photographs showing the structure of both hard and soft tubes. There are in addition descriptions of electrical chemical and voltage tests to determine the liability of tubes to corrosion.

BULLETIN

A bulletin has been issued by the Goldie McCulloch Co. of Galt, describing the V-type Rees Ro-Turbo pump, for services up to 1,000 Imperial galons per minute. These pumps will deal with liquids of a viscous nature, such as thick oil, sugar, etc. An illustration of the pump with the top half of casing opened up is included in the bulletin, and the necessary information required by the company for quotations is indicated.

THE OLDEST ENGINEER

Mr. Alfred Ablitt, who is an engineer in the Consumers' Gas Co., was recently presented with an illuminated address by his fellow engineers in the company. The occasion was the completion of his fiftieth year in the employ of the company. Mr. Ablitt is said to be the oldest engineer in the province of Ontario.

Several contracts have been awarded for additional work to the Cambridge St. school, Ottawa, totalling $55,000.

Refrigeration For The Power Plant Engineer

The Expansion Valve and Its Function. The Direct Expansion and Brine Methods of Cooling Are Briefly Described, and Tables of Salt Solutions Given

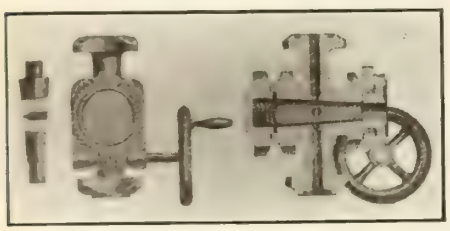
By T. H. FENNER

THE LAST point reached in the study of the mechanical refrigeration system was the liquid receiver, the course of the ammonia gas and liquid having been traced from the compressor to this point. The next important point in the circuit is the expansion or regulating valve.

The Expansion Valve

The function of the expansion valve is to pass ammonia at high pressure through a small opening into the low pressure side of the system. The liquid passes from a pressure of from 125 to 175 lbs. into a pressure of 15 lbs. to 25 lbs. The valve is capable of very fine adjustment, as it is upon the amount of liquid passing this valve that a great deal of the successes of the system depend.

It is a common statement that the ammonia liquidation passing the expansion valve "flashes into gas." The ammonia liquid does not flash into gas immediately, but passes to the low pressure side of the regulating valve as a liquid. If there is not the necessary heat available on the low pressure side of the system to evaporate it it will remain a liquid. Also when it arrives at the low pressure side it is at a temperature corresponding to the temperature on the high pressure side, and before taking up heat to transform it into a gas it must give up some of its temperature to the brine or surrounding air, till the temperatures are equal. When this is



Expansion on Regulating Valve

done, it will take up heat to supply the necessary latent heat to make the transformation from liquid to gas

A typical regulating or expansion valve as used by the De La Vergne company is illustrated. It will be noted that the opening of the cock is accomplished by means of a worm and worm wheel, thus allowing the most delicate adjustment. In other types a graduated wheel is used, the plug of the cock having a pear shaped or diamond shaped opening, allowing very delicate shades of adjustment.

The result of passing too large quantities of liquid through the expansion valve would be to have liquid remaining in the coils when the suction side of the compressor is reached, there not being sufficient heat available in the cooling chambers to evaporate the liquid passing through. A too wide opening, carried to the extreme, would naturally result in the pressure in the high and low side of the system being equalized. Another effect of a too rapid flow of liquid would be an intense cooling effect with formation of heavy frost on the pipes close to the expansion valve, thus forming an insulator which would prevent the liquid being evaporated until it had passed the point of frost. In this way the coils would gradually become flooded, as mentioned previously.

The Liquid Trap

Before the gas enters the refrigerator, it is passed through a trap which precipitates any oil or liquid still remaining in it. This trap is placed between the expansion valve and the refrigerator and saves any foreign matter from reaching the coils. This trap is provided with means of cleansing or draining, and should be carefully watched and attended to regularly. Lots of trouble arises on refrigerating systems, through some neglect of the oil separators and liquid traps.

The Direct Expansion System

The direct expansion system, as its name implies, is one where the ammonia coils are placed directly in the rooms to be cooled. The heat is then absorbed directly from the contents of the room by the evaporating liquid. These coils may be placed on the side of the room or on the ceiling, while in some cases where the material to be cooled is liquid, the double pipe system is used, in a similar way to the double pipe condenser. There is a modification of this in that the pipe containing the liquid to be cooled is made in corrugated form, in order to prevent liability to bursting should freezing occur.

The amount of coil surface required will vary with the temperatures to be maintained. In cooling rooms by evaporating ammonia liquid in coils the latent heat of the liquid as well as the difference in temperature is utilised. There is usually a difference of about ten degrees between the temperature of the room and the temperature of the gas in the coils. The usual proportion of cooling surface allowed in freezing tanks is from 40 to 50 square feet of external pipe surface to each ton of refrigerating capacity. This will mean about 150 linear feet of 1 inch pipe, or 100 feet of 1½inch pipe and 80 feet of 2 inch pipe.

The Brine System

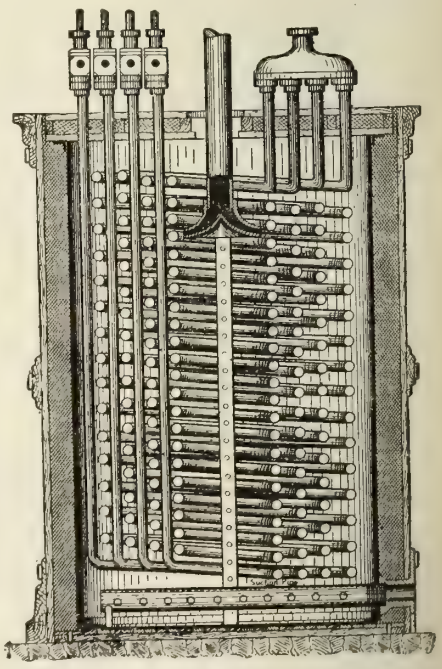
With the brine system more apparatus is required, including pumps for circulating the brine, and tanks for storage as well as the actual brine cooler itself.

The brine itself is a solution of chloride of calcium, or chloride sodium (common salt) and water. This solution has a very low freezing point. The chloride of calcium brine may be made of such density that its freezing point will be minus 54 degrees, or 54 degrees below zero, while the salt solution has a maximum density. Chloride of calcium brine has also the advantage that it is not corrosive.

The Baume scale is the one used to determine the specific gravity of the mixture, a graduated weighted bulb and tube being used. The height of the bulb and tube afloat in the solution gives it specific gravity. The tables herewith give the properties of both the calcium and brine solutions.

The brine cooler may be of the double pipe type, or it may be of the submerged type, the ammonia coils being submerged in the brine. The brine is often kept in circulation in the brine tank by an agitator, to ensure all parts of it coming in contact with the coils. The suction of the brine pump should be kept above the bottom of the tank so that it does not get clogged up with any solid matter that may have come to rest on the bottom.

If a large quantity of brine is kept in a storage tank, there is a considerable reservoir of refrigerating effect, and it is often the practice to keep rooms cool at night by circulating brine that has



Circular Brine Tank with four ammonia coils. Brine is drawn off through perforated pipe in bottom of tank. An expansion valve is fitted to each coil.

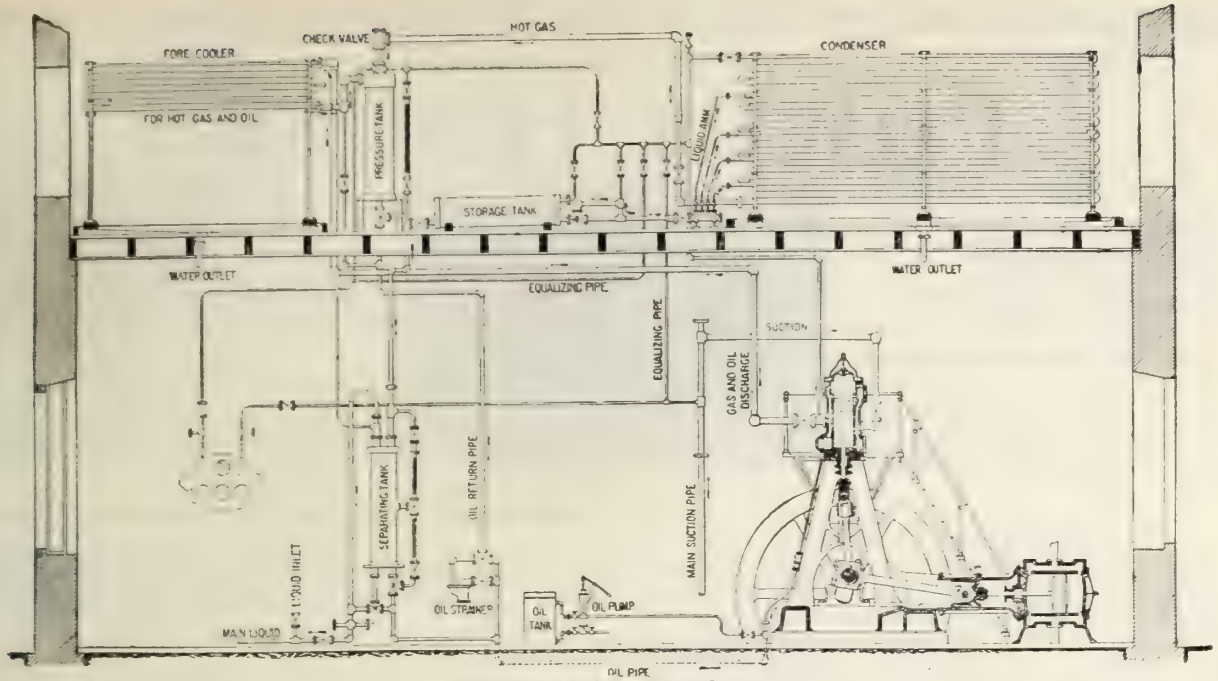


Diagram of Refrigerating Plant.

been cooled during the day when the machine was running.

An indirect method of cooling by brine is to place the brine tank underneath the ammonia coils, and to pump the brine in a spray over the ammonia coils. The whole arrangement is placed in a separate insulated space, and the air from this space is pumped through the room to be cooled, much in the same manner as air is used in the indirect heating system.

In using the brine system, more coil surface must be used for the ammonia, the proportion being about 50 per cent. more for brine than for direct expansion.

CHLORIDE OF SODIUM BRINE

Degrees on Salinometer	Pounds Salt per gallon	Freezing Pt. Fahr
0	0.	32
5	0.105	30.3
10	0.212	28.6
15	0.321	26.9
20	0.433	25.2
25	0.548	23 6
30	0.664	22
35	0.728	20.4
40	0.897	18.7
45	1.019	17.1
50	1.142	15.5
55	1.265	13.9
60	1.389	12.2
65	1.522	10.7
70	1.656	9.2
75	1.791	7.7
80	1.928	6.1
85	2.067	4.6
90	2.207	3.1
95	2.347	1.6
100	2.488	0.

We have illustrated here a diagram of a complete refrigerating plant the evaporation or suction side only not being shown. This may be either direct or brine system.

We shall take up in our next article the absorption system of refrigeration. This system is not nearly so well understood by the average man as the compression system, and there are not very many o fthem in Canada comparison with the compression machines. However, there are enough of them in use in this country to make their study necessary for any one who claims to understand refrigerating machinery, and we shall therefore give a general description of them with perhaps a little more detail than has been given of the compression plant.

CALCIUM CHLORIDE BRINE

Deg. on Salinometer	Pounds per gallon	Freezing Pt. Fahr.
0	0	32
4	0.167	31.1
8	0.333	30.33
12	0.5	29.48
16	0.667	28.58
20	0.883	27.82
24	1	27.05
28	1.167	26.28
32	1.333	25.52
36	1.5	24.26
40	1.667	22.8
44	1.883	21.3
48	2	19.7
52	2.167	18.1
56	2.333	16.61
60	2.5	15.14
64	2.667	13.67
68	2 833	12.2
72	3	10
76	3.167	7.5
80	3.333	4.6
84	3.5	1.7
88	3.667	minus 1.4
92	3 833	minus 4.9
96	4	minus 8.6
100	4.167	minus 11.6

CROSSED BELTS

The Editor,
The Power House.

Dear Sir—The writer desires to point out an error in the fourth paragraph of an article by Mr. John Thorn on page 32 of your May 5th issue, regarding the length of a crossed belt.

The Rule given for finding this length should have read:—

Add together the diameters of both pulleys, divide by two and square this quantity, also square the distance between centres and add to the first square. Extract the square root of the above sum and multiply by two. Add to this half the distance round the outside of both pulleys.

Example:—Suppose a belt travelling crossed over pulleys two and four feet in diameter at ten feet centres. The length of this belt is obviously well over twenty feet.

By Mr. Thorn's formula we get the length to be:—

$$[\sqrt{(4^2+10^2)}-10]2+(4+2)\ 3.1416 = 20.38.$$

By the rule as given above we get a length of:—

$$\sqrt{\left\{\left(\frac{4+2}{2}\right)^2+10^2\right\}}2+\frac{(4+2)\ 3.1416}{2} = 30.2$$

It can be seen at a glance where the error is.

It might be here noted that the rule for open belts is identical with the above, except that you start by taking the difference between the diameters of the pulleys instead of adding them.

Yours etc.
ENGINEER

Member of the Audit Bureau of Circulations

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Super Power Stations

EVIDENTLY all the huge steam electric power generating stations are not going to be located in the United States, judging from the account of the plant now being erected in Manchester, England. The first section of this station will contain turbo generators for the supply of 90,000 kilo watts, which will be generated at 6,600 volts, 50 cycle three phase. The transformer rooms for stepping up to 33,000 volts for transmission purposes are located in a separate building running parallel with the turbine room. This station is particularly well situated both in regard to an amply supply of circulating water, and facility for handling coal supply. The site covers 13 acres on the banks of the Manchester Ship Canal, and a special embankment has been made for the coal barges, which bring coal from collieries only four miles from the station, by way of the Bridgewater Canal, a small canal adjoining the large one.

The boilers for this station are Babcock & Wilcox, containing 16,000 square feet heating surface, and placed back to back, making them double ended from the firing point of view. They will generate steam at a pressure of 375 lbs. per square inch, and will be fitted with superheaters, steel tube economisers, and balanced draught regulation. The condensers will each have an area of tube surface of 40,000 square feet, and the weight of each condenser without the tubes will be 50 tons.

The culverts for the supply of condensing water, which will be drawn from the ship canal itself, and returned to it, are of such size that they will allow for the flow of 7½ millions of gallons per hour. This is an enormous quantity of water, and it shows the prime necessity of a station of this kind being located where water is easily available, and to be obtained for the cost of pumping only. This amount of water would be sufficient to supply the needs of a city of 750,000 people.

In order that the circulation of such a quantity of water will have no effect on the ship traffic, the inlet and outlet is arranged to take place over a large area, and in such a way that the outlet is discharged below the surface of the water. In the outlet chamber there is a long central weir, for measuring the amount of water used. These inlet and outlet culverts are driven directly through the red sandstone rock which forms the foundation of the station. This station is one of the first of the proposed super-power stations to be erected in England, and it will be interesting to see later on how its performance compares with that of the large stations in the United States. The proximity of the coal fields and the water haulage should make for a cheap fuel supply.

Steam electric stations in England had a very low cost per kilo watt hour in pre war days, when coal was cheap, and labor normal. Both coal and labor are at higher rates now than in those days, and it will be interesting to see how the large stations will compare with the performance of those earlier days.

The city of Manchester possesses a number of interesting stations, but this will be the shining light for them all when completed.

* * * *

Special Certificates

THE MEMBERS of Ottawa Lodge C.A.S.E. have forwarded a protest to the Board of Stationary Engineers, against the attempt of some party or parties to have special certificates issued to firemen or engineers in small factories such as cheese factories and dairies. The special certificate is asked for in places where no more than seven persons are employed. The request is said to embody a lowering of the experience necessary, and also a reduction in the fee for the examination.

The first glance looks like an attempt to get around the provisions of the stationary engineer's law, and admit men who could not otherwise qualify. However, looking more closely into the matter, the idea may not be so dangerous as at first appears. As a general rule, these dairies, cheese factories, small canning factories, etc., are only working for a limited period of each year, and it may be a matter of some difficulty to obtain a man with the necessary qualifications to operate them for the limited period. The apparatus usually consists of nothing more than a boiler, and perhaps a small engine, the auxiliary apparatus being limited to a pump or injector.

It is of course necessary that the man who is to operate these appliances shall be acquainted with them sufficiently to make him a safe operator, but it does not require any great length of experience to ensure this. There is apparently no attempt to have totally unqualified men operate them, but the object of the request would seem to be to enable a local man, who would always be available to operate when necessary.

While we are in entire sympathy with the regulations being rigidly enforced, it seems that in this case too narrow a view might work unnecessary hardship on a class of small manufacturers, whose profits are none too great at any time. We may be wrong in our estimate of the situation, based on the account in the daily press. If so we should be glad to be corrected.

From our knowledge of the type of plant in question, what is really required is a much more rigid inspection law than the one now in force. Many of these boilers are in a state bordering on decrepitude, and it is very difficult to impress on many of the owners the danger of allowing the boiler to deteriorate to such an extent. We have seen some pretty bad cases, and these made us think that there must be many more in worse case that no one ever inspects.

In this direction there is undoubtedly room for improvement.

Management of Direct Current Machinery

By M. BARRY WATSON
Director of Engineering, Toronto Technical Schools.

PRACTICALLY all electrical machines have self oiling bearings. The smallest ones are generally oiled by means of a wick, one end of which rubs on the journal, the other hanging in an oil well. The usual type of bearing oiler on the larger machines consists of two or more rings which hang over the journal, passing through grooves in the bearings, their lower sides hanging into the oil well. As the shaft revolves, these rings revolve with it, carrying oil from the well to the bearings. With properly fitted bearings and good oil there should be absolutely no trouble with these. This is one cause, however, of neglect of the oiling system, and sometimes a hot box or warm bearing causes disastrous results, whereas it could have been avoided by a periodical inspection of the bearings.

The oil wells must be kept full enough for the rings to dip into the oil, but must not be too full or oil will be thrown out along the shaft. Some machines have overflow holes to prevent filling too full. These should of course be kept clear. To prevent the oil creeping along the shaft under normal conditions, a collar is turned on the shaft which throws any oil which travels that far into the overhanging part of the bearing housing and cap, from where it runs back into the oil well.

The oil should be changed about once in six months for a normal amount of running, or oftener if it becomes dirty or causes the bearing to heat. New oil should be strained if it appears to contain any foreign matter. Only the best grades of dynamo oil should be used, as they are specially made for electrical machinery. In an emergency, however, any good grade of engine oil may be used temporarily, with little chance of damage being done. The oil wells should be thoroughly drained and washed out with gasoline before new dynamo oil is put in.

If oil is to be used a second time, it should be filtered and allowed to cool. The bearings and oil wells should of course be kept free from dirt and grit at all times. When cleaning or other work is being done on other parts of the machine or in the vicinity, the bearings and oil holes should be protected from dirt.

For large turbo-generator sets a closed oiling system is used in which the oil is pumped into the bearings with sufficient pressure to float the journals on a film of oil. The oil pressure is generally supplied by a pump geared to the turbine, but an auxiliary pump must be used when starting, as the revolving parts are so heavy that all oil is squeezed out from the bearings when the pressure is not on, and if the machine were run in this condition the bearings would be ruined.

Hot Boxes

A warm bearing or "hot box" may be caused by any of the following conditions, the remedies for some of which are given, remedies for the others being obvious:

1—Belt too tight.
2—Lack of oil in oil wells.
3—Oil rings jammed or not revolving.
4—Dirt in oil, or poor grade of oil.
5—Too tight fitting of journal boxes. (Remedy.—Ease off the cap bolts, and when the machine is shut down either put an extra shim under the cap, or scrape the bearings to fit properly.)
6—Rough surface on the journal. (Remedy.—A new shaft, as straightening can seldom be done successfully. If the bend is close to the journal, the latter can sometimes be turned down to a smaller diameter concentric with the straight part of the shaft. This requires special equipment to which most engineers have not access.)
8—End thrust of the revolving part. (Remedy.—If this end thrust is due to improper levelling of the machine, it may be re-levelled. If due to magnetic pull, it is a factory job, although some relief can be obtained by setting the axis out of level sufficient to compensate for this pull at an average load condition.)
9—Excessive side pull, due to armature not being central between field poles. The same effect as a too-tight belt. (Remedy.—The bearings should be relined with equal clearances between armature and all field poles, or the field poles may sometimes be shimmed out from the frame with sheet iron or sheet steel shims the full size of the field core.)
10—Bearing at pulley end worn out of line by pull of belt. (Remedy.—Reline the bearings.)

If a bearing becomes hot while running, feed it with heavy oil, loosening the cap bolts slightly and slackening the belt as much as possible. If this does not prevent further heating throw all load off the machine, but keep it running slowly with plenty of heavy oil until it is cool. This is to prevent the bearing freezing. Never try to cool a bearing with water, as this is most likely to freeze it. A frozen bearing can sometimes be loosened with kerosene. The oil wells will, of course, require cleaning out before the machine is again started, and a liberal application of new oil applied.

A new machine should be run for a few hours without load and at slow speed if possible, before being put into service to see if the bearings are all right.

Oscillation of Rotating Parts

Belted, geared or engine-driven machines are generally found to oscillate more or less regularly along the axis of the shaft, if properly levelled, due to external forces. A motor-generator, or rotary converter on the other hand tends to assume a fixed position with relation to the bearings. When no oscillation takes place grooves are likely to be worn in the commutator or collector rings and shoulders on the journals, thus demanding more care and careful inspection.

A mechanical oscillator is sometimes provided to insure the oscillation of the rotating parts along the line of the shaft. The simplest type of mechanical oscillator consists of a steel ball and circular steel ball race, backed by a spring mounted opposite to, but not quite parallel to, the end of the shaft. The machine is installed not quite level so that the shaft tends to move toward the end where the oscillating mechanism is

mounted. The ball race is so adjusted that the ball is in light contact between it and the end of the shaft. As the shaft revolves the ball is carried into the converging space between the end of the shaft and the race, forcing the latter against the spring which it compresses. The reaction of the spring pushes the shaft away from its position, allowing the ball to drop back to the bottom of its race. The shaft and rotating parts continue to move axially until gravity brings them back ready to repeat the above process. The only care and maintenance required by a mechanical oscillator is to keep it clean and lubricated with light oil.

Starting Up Generators

The process of starting up a generator is so simple as to need only a few remarks on some of the causes of the machine not starting properly, etc.

Before starting up a generator see that all resistance is cut in the shunt field circuit, that the oil rings are free to turn, that there is plenty of oil in the bearings, also that the brushes are bearing evenly but not too loosely or too heavily on the commutator. Then start up slowly and if everything operates properly bring up to full speed. Adjust the field rheostat slowly to the normal voltage position and throw on the load. Always use the main switches for throwing on the load, never the circuit breakers. These latter should be closed and ready for operation before the main switches are closed in order that they may open in case of a short circuit on the line or too much load connected, and thus protect the generator.

Low Voltage

Sometimes generators fail to build up full voltage upon starting up. This condition may be attributed to any of the following causes.

1—Speed too low.

2—Brushes not correctly set.

3—Loose connection or other unnecessary resistance in the shunt field circuit.

4—Part of the shunt field circuit may be short circuited, or field coils may be connected in opposition.

5—Series fields may be reversed and "bucking" the shunt fields.

6—A dead shortcircuit on the armature.

7—Voltage may be correct, but the switchboard instruments at fault.

No Voltage

No voltage may be the result of:

1—Wrong direction of rotation.

2—Reversed armature connections.

3—Broken field coil windings or connections.

4—Brushes not touching the commutator.

5—Any of the causes of low voltage as given above.

6—Loss of residual magnetism in the fields.

Compound wound machines may sometimes be made to build up by shortcircuiting the armature through the series field and in series with a piece of fuse wire of slightly less capacity than the generator. Start up the machine gradually. If the fuse wire melts, try to get the machine to build up again, or reverse the armature connections and try again. If the wire does not melt, the trouble is obviously one of the above.

Reversed Voltage

Reversed voltage is generally caused by a reversal of the residual magnetism in the fields. This is liable to occur if a compound generator is operated as a motor while shutting down with a weakened shunt field. It can be corrected by applying correct voltage to the shunt field for a few moments from an outside source.

To Reverse Direction of Rotation

If a generator is required to be driven in the opposite direction, reverse the shunt field leads and the series field leads, or reverse the armature and the commutating pole leads. This applies to generators or motors.

Paralleling Generators

To parallel a D.C. generator with others already on the line, bring it up to normal speed, adjust voltage to that of the line by means of the field rheostat, throw in equalizing switch then main switches. The proportion of the load carried by each machine can be controlled by adjustment of the shunt field rheostats. In most cases machines are not equalized for all loads and the rheostats require adjustment as the load changes in order to keep the load properly distributed.

Shutting Down Generators

In shutting down a generator, proceed as follows:

1—Reduce the load by adjusting the shunt field rheostat.

2—Open the circuit breakers.

3—Open the main switches.

4—Open the equalizing switch.

5—Shut down the engine or other driving machine.

6—Clean up machine ready for next run.

Starting Up Motors

To start constant speed motors:

1—Make sure that the lever of the starting rheostat is in the "off" position.

2—Throw in main switch.

3—Move lever arm of starting box to running position, holding it on each notch until the speed has risen as high as it will before going to the next notch.

In starting variable speed motors:

1—See that all resistance is cut out of the shunt field circuit, or that it is in the "slow" position.

2—Proceed as for constant speed motors.

3—Cut in shunt field resistance until desired speed is reached.

Shutting Down Motors

Constant speed motors should be shut down as follows:

1—Open main switch or circuit breaker.

2—See that lever arm of starting box returns to "off" position.

3—Clean up ready for next run.

For variable speed motors proceed as follows:

1—Cut out all resistance in shunt field circuit, bringing motor to "slow" speed.

2—Proceed as for constant speed motors.

(To be continued.)

HANDY RULES

By James Ellethorne

The following information may be of use to Power House readers. Printed rules describing methods for finding the contents of barrels are quite numerous. Some of them, to say the least, are unreliable, and they would not even give the approximate contents. Every engineer should know at least one fairly reliable rule of this nature. I remember the first time my employer asked me to inform him how many gallons a certain barrel would hold. At that time I did not know how to solve the problem and was compelled to confess my ignorance. I believe the following rule is fairly reliable: Find the mean diameter by adding to the head diameter two-thirds (if staves are but slightly curved, three-fifths) of the difference between the head and bung diameters, and divide by two. Multiply the square of the mean diameter by 0.7854 and the product by the height of the barrel in inches. Then divide by 231 for wine gallon, or by 277.27 for Canadian gallon.

Another handy rule to mark down is how to approximate the height of a stack or other object. Take a stake, say six feet long, and place it against the building whose height is desired. Then step back some 20 rods or more. At this point a light pole and a rule are required. The pole is raised between the eyes and the building and the rule is brought into position against the pole. Then observe the length of rule required to cover the stake at the building, and also the entire building. Divide the latter length by the former and multiply by the length of the stake in feet; the product is the approximate height of the building. For example: suppose the stake at the building is 6 feet above the ground and that one inch of the rule corresponds exactly with it. Then if the entire height of the building corresponds exactly with, say, nine inches on the rule, it would show the building to have a height of 54 feet. This is an old formula. I have endeavored to put it into a simpler form than that usually given.

The Grindle Fuel Equipment Company, Harvey, Ill., have issued their first general catalogue describing the powdered fuel equipment manufactured by them. The catalogue is very well got up, containing forty pages of reading matter and illustrations, covering the subject of powdered fuel generally as well as the equipment manufactured by the firm itself.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

HEATING FEED WATER

Question:—How many pounds of water would be heated if the water entering the heater was 60 degrees F. and leaving the heater was 160 deg. F. and the steam was at atmospheric pressure?

Answer:—As the quantity of steam is not given, we will take the heating effect of one pound of steam. Each pound of steam in condensing from steam at atmospheric pressure to water at atmospheric pressure will give up 967 heat units, and in dropping from 212 to 160 a further 52 heat units will be given up, a total of 1,019. Each pound of water is raised from 60 to 160 degrees, therefore the heat required is 100 B. t. u. per lb. of water. Each pound of steam will therefore heat 10.19 lbs. of water from 60 to 160 degrees.

AQUA AMMONIA

Question:—What is the difference between aqua ammonia and liquid ammonia?

Answer:—Aqua ammonia is the name given to a solution of ammonia and water, aqua being a Latin word meaning water. When ammonia gas is compressed to a high pressure, and the heat of compression removed, it condenses and becomes a liquid. This is liquid ammonia, or anhydrous ammonia, meaning ammonia liquid which is entirely free of water.

Question:—What effect would oil, water, or air have on a refrigerating system, also what means is there for removing same from system?

Answer:— The effect of any foreign matter or non-condensible gases in a refrigerating machine is to decrease the capacity. Oil will cling to the surface of the coils acting as an insulator preventing the transfer of heat. Air will act in a refrigerating system in much the same way that it does in a heating system. It will occupy the space which the ammonia should occupy, and so much cooling effect is lost. The place to draw off the oil is from the bottom of the oil separator, by means of the drain valve placed there. Air and other non-condensible gases may be drawn off by the purge valve at the top of the condenser.

AIR PUMP OR BLOWER

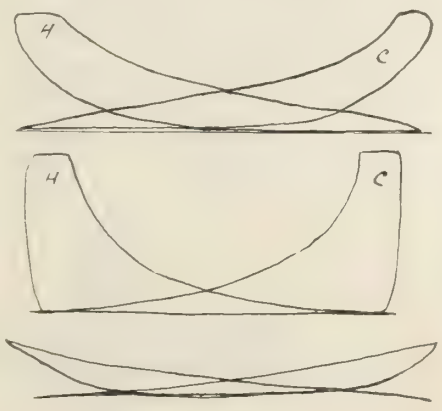
Question:— What is the difference between an air pump and an ordinary steam driven air blower?

Answer:—The term air pump is usually given to the pump used for drawing condensate and vapor from a surface condenser, or a barometric condenser. It is also applied to the pumps used in laboratory work for exhausting air from a vessel to produce a partial vacuum. The air compressor or blower takes in air at atmospheric pressure and raises it to a higher pressure, while the air pump works with atmospheric pressure as its upper limit. Both pieces of apparatus are air pumps, or air compressors, but the different duties are indicated by the term air pump or air compressor. The air pump is an air compressor because it draws in air and water vapor, or air at less than atmospheric pressure and compresses it to atmospheric pressure or slightly above so that it can be discharged against the pressure of the atmosphere. The air compressor or air blower may be termed pumps because they draw air in at atmospheric pressure, and deliver it to a closed system at a pressure of 7 to 100 atmospheres.

INDICATOR CARDS

Question:— What would good indicator cards look like from an engine running on a throttling governor, an automatic engine, and a Corliss all running on light loads?

Answer:—The following cards are actual examples from the types of engines mentioned, and submitted to us by Mr. Allen Norgrove, Chief Engineer, Le Pas Lumber Co., Le Pas, Manitoba.



Top—Card from automatic.
Centre—Card from Corliss.
Bottom—Card from throttling engine.
All on light lead.

CORLISS VALVE GEAR

Question:—Why is it not possible to set the valve of a Corliss engine to trip at more than half stroke, and still use steam economically?

Answer:—The cut off point in a Corliss gear is adjusted by means of the position of the governor rods which in turn operate the knock off cams on the valve spindle. These governor rods by being lengthened or shortened move the cam nearer or farther away from the steam hook, causing earlier or later cut off. If the valve gear is driven by one eccentric, cut off can not be made any later than half stroke for this reason. With the crank on the dead centre, the eccentric is in the centre of its stroke. When the crank reaches half stroke the eccentric is at the limit of its travel and is starting on the back stroke. If the knock off cams have not reached the steam latch by this time, it is impossible for them to do so, and the hook will not disengage, the result being that the steam valve is kept open for practically the entire stroke. Before the steam valve closes the exhaust valve opens, and the steam is blown straight through the cylinder from the steam chest to the exhaust pipe. In order to obtain a water cut off the half stroke it is necessary to have two eccentrics, so that the exhaust valves can be adjusted independently of the steam valves. By setting the steam eccentric so that the crank will have passed over the half stroke before the eccentric reaches the end of its travel cut off can be made later than a half stroke.

CONDENSATION AND RE-EVAPORATION

Question:—What is meant by condensation and re-evaporation in a steam cylinder of an engine?

Answer:—In the ordinary reciprocating engine the cylinder is being alternately exposed to steam at the initial pressure and temperature and to steam at the exhaust pressure and temperature. The steam at admission is introduced to a point where the walls of the cylinder have been subjected to the cooling action of the exhaust steam. Some of the heat of the steam is therefore absorbed in heating up the cylinder walls to the temperature of the steam, the result being that a portion of the steam is condensed. This will appear as a thin film of water on the cylinder walls. As the steam expands, it lowers in pres-

sure and temperature, until the temperature of the steam is less than that of the walls of the cylinder. This causes heat to be taken from the cylinder walls, which is absorbed in re-evaporating a portion of the moisture in the cylinder. Thus we have condensation at one point of the stroke and re-evaporation at the other. It is to avoid the losses due to this that the Uni-flow system is designed. In this engine the steam does not exhaust through the same ports as it is admitted, as in the ordinary engine. The exhaust ports are situated in the centre of the cylinder, and the piston is made long enough to cover them except at the end of the stroke. Release takes place when the piston uncovers the port, and compression occurs very early in the return stroke, so much so that in most cases provision has to be made to allow the escape of a portion of the steam when the piston reaches the initial position. In this way the admission ends of the cylinder are kept at practically a constant temperature while the exhaust always takes place in the centre and thus any sudden changes of temperature are avoided.

EFFECT OF REDUCING VALVE

Question:—What would be the effect on the steam of passing superheated, saturated, and wet steam through a reducing valve, for heating purposes?

Answer:— When steam is expanded from high pressure to low pressure without doing work, its temperature at the lower pressure will be higher than that corresponding to its pressure. In other words it will be superheated. Passing steam through a reducing valve is expanding it without performing work. If superheated steam is passed the result will be that it will have a higher superheat on the low pressure side. If wet steam is passed through a reducing valve part of the heat will be absorbed in evaporating the moisture, and the result will be that the wet steam will appear as saturated or slightly superheated steam on the low pressure side, while if the steam is saturated on the high pressure side it will be superheated on the low pressure side.

LOST MOTION ON PUMP VALVES

Question:—What is the purpose of the lost motion on the steam valve of a duplex pump?

Answer:—Take the position of the valves when the two driving levers are vertical, and the valves in mid-position which is the correct one. The valves are just covering the ports, and there is enough slack on the check nuts or lugs of the valves in themselves to allow them to crack the port on either end. Now take a bar and move one rod to the end of its stroke. We have moved the valve on the opposite cylinder to the end of its stroke, leaving it open for steam and it will in turn move to the end of stroke at the same time opening the first valve to give steam to the position first moved. and causing it to return. If there were no slack on the valves the rods would come in mid position again at the same time, and the valves would cover the ports on both cylinders at the same instant, the result being that the pump would stop. Owing to the fact that at the commencement of the stroke the pump rod must move sufficiently to take up the slack in the valve spindle before it moves the opposite rod, the two rods never pass the centre at the same time one always being in advance of the other and thus there is no dead centre. This same factor ensures the valve remaining open to steam until the piston has completed its stroke.

STEAM GAUGES

By J. E. N.

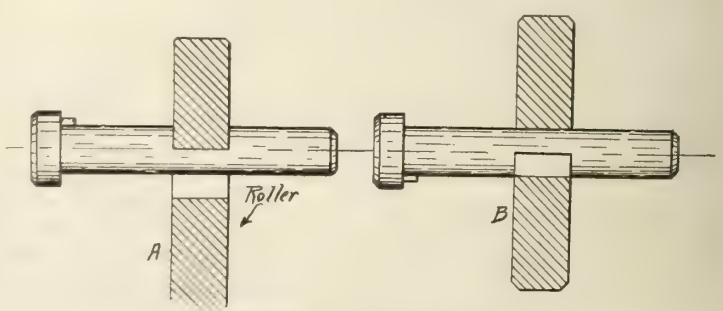
There are a large number of perfectly good steam gauges discarded, especially in small out of the way plants in country districts, cheese factories, etc. Many of these plants have good men in charge, men who understand and carry out their work quite as regularly and capably as the man in the large city plant, perhaps better in some cases. When the law permits it, some of these small plant owners have them operated at as low a labor cost as possible. This may mean that a cheap, indifferent operator is in charge. Such a man usually discards a gauge when it registers high or low, or if the hand checks at any point, that is, if he does anything in the matter at all. He tells his employer it is beyond repair and to get him a new one. The old one is discarded without examination. The methods of cheap, inexperienced power house help are usually costly to the owner. Probably the old gauge is as good as the new one. Sometimes a little dirt gets inside the casing and lodges in the small gear teeth, or, perhaps some time in the past a thin oil has been placed on the mechanism and become gummed with the heat and dust. Washing the mechanism in gasolene and allowing it to dry in a clean atmosphere will prove a cure in either case. When cleaning the mechanism of a steam gauge no oil heavier than coal oil should be used and it is better to wash it off with gasoline, as the coal oil can, and sometimes does, collect enough heavy dust to affect the operation. The mechanism is very delicate and little is required to interfere with its proper operation. If a man has not the skill or knowledge to do repairs it is not costly, and it is safer to have an experienced outside man do it. I have seen a man using a fairly rough file and a heavy pair of pliers in an attempt to repair a gauge. Often a gauge will register correctly up to a certain point and neither cleaning or setting the indicating hand makes any improvement. Several things may be wrong. It may be caused by lost motion due to wear, perhaps there is a very small leak in the spring, or the spring has hardened or softened. The average engineer can not remedy these defects.

The Pacific Meat Co., 268 Columbia St., Vancouver, B.C., is considering the erection of abattoir and cold storage plant which will cost around $100,000.

WHY THE EXHAUST VALVE DID NOT WORK

By G. Blake

The writer, whilst working in a general repair shop some years ago, was one day sent out by the foreman to examine a gas engine in a bakery, the complaint was that it pulled up when the load was on. The engine was of a very old type, but it seemed to be in good working order as far as the writer could ascertain, the pulling up with the load on indicating that some part was not functioning properly. When the engine was running it was noted that the small cam roller, which actuated the exhaust valve mechanism, appeared to have a very small amount of lift, the engine was accordingly shut down and the roller examined and it was discovered that the pin on which the roller worked had become worn on the top side, that is the side on which the thrust took place when raising the valve to exhaust the exploded gases. This pin was worn practically half way through, see sketch A, consequently the valve did not open sufficiently to allow the gases to escape, which would account for the pulling up when the load was on. The old pin was turned half way round so as to present the unworn part to the bore of the roller, see sketch B, thus giving the valve nearly the proper amount of lift. This of course was only a temporary adjustment until a new pin could be made. The engine pulled all right on lead after this simple alteration.

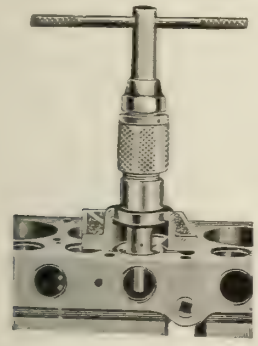


Why the exhaust valve did not work.

Progress in New Equipment

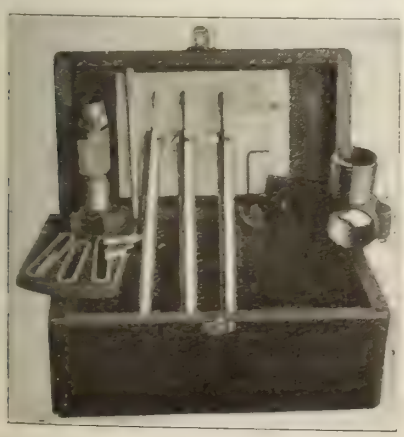
VALVE RESEATER

A very important factor in the overhauling of motors and pumps is to see that the valves seat properly and to do this they must be in perfect alignment with the valve guides. A device for performing this has just been placed on the market. This appliance does not depend on the small pilot end to guide the cutter, but the latter is guided by a large accurately ground bearing above the valve seat. A screw feed is provided and the tool is held steadily to the work, and no digging in or chatter takes place. When refacing valve seats top and bevel are both faced so that a narrow and effective seat is always presented to the valve, thus aiding in expelling the carbon. Cutters are made of high speed



Valve reseating tool.

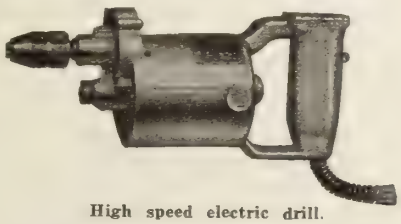
steel and shop and garage men can resharpen and keep them in shape. The set consists of three boring bars, with 5/16in., ⅜in. and 7/16in. pilots; two valve seating cutters, 45 deg. angle; one knurled handle; two boring cutters and wrench. All incased in mahogany finished chest. Weight, 18 lbs. It is manufactured by the Hinckley Machine Works, Hinckley, Ill.



Valve reseating and boring set in mahogany case.

SMALL ELECTRIC DRILL

A small but highly serviceable electric drill has just been offered to the trade. It is extremely compact and has remarkable strength for drilling ¼in. holes in steel. It weighs only four pounds and can be supplied with either 110 or 220 volts motor, suited for direct or alternating current. It is amply provided with oiling and ventilating facilities, and is fitted with bronze bushings and



High speed electric drill.

gears. The drill can be held and operated with one hand, and chuck and drill are always in view of operator. The Lovejoy Tool Works, Chicago, Ill., are the makers.

LIGHT OR HEAVY OIL

By James E. Noble

I thought I was a "wise one" where lubricating oil for steam engine is concerned, but I was told a thing or two a short time ago by a fellow, that has taken some of the conceit out of me. I had been doctoring a boiler feed pump which was making a disagreeable noise, when it was running. I tried several things without success, loosened up the packing on the water plungers, etc., but with no verdict of cured as a result. Well, the fellow in question advised me to use a lighter oil, but with a high flash test. I am always willing to try out a thing once if it looks reasonably safe, so I tried out his suggestion and the noise quit. I went back to the heavy oil and the noise, which was a sort of groaning one, started again; a return to the light oil made a permanent cure. I remember talking with a man who had this same idea; he also claimed that less of this kind of oil could be used than a thick oil, with better results. Of course, a thin, low flash test oil, would be no good, although I know a would-be inspector who advises his engineer friends to use a thin low flash test oil so that it will vaporize in the cylinder and thus oil the walls. Of course he is making a mistake, as such an oil would practically all pass out with the exhaust steam without doing any good.

USING WASTE STEAM

With coal at its present high cost and a shortage in the near future possible, any idea which will tend towards a saving should be welcome. Hundreds of steam plants shut down every Saturday at noon, others do so the day preceding every holiday. In many of these plants the fire is allowed to die out along with the steam pressure in the boilers. This is especially the case during the summer months, the fire not being re-started until early Monday morning. Surely, in most cases, some plan could be arranged so that all the steam possible to take out of the boiler or boilers could be used for some purpose, be it drying, boiling or otherwise, with the partly burned fires allowed to do their utmost, by throwing the dampers open, and using the large amount of stored heat in the boiler water, settings, etc. The quantity of heat available would be considerable. It seems a pity that all this steam is wasted when a bit of thought might devise some plan to save it. I remember hearing or reading about one man who secured from 2 to 8 hours drying oven service from such steam formerly wasted. I believe if engineers in plants should draw their employers' attention to plans of this nature their interest in the plant and its possibilities would be welcomed by the owner.

BULLETINS

We have received from the Atlas Valve Co., a handbook on reducing valves, which they state is the result of their fifteen years experience in the manufacture of this line. The book contains a large number of charts and formulae connected with the flow of steam through pipes, and the question of using the right size of reducing valve for job in hand clearly explained.

The Barber Greene Co., Aurora, Ill., have sent us their bulletin describing their U Belt Loader for reclaiming coal from storage or unloading from cars to storage. This is a portable conveyor, having the added feature of being self propelling, so that there is no labour needed to move it from one place to another. Accompanying the bulletin is a data sheet containing more detailed information.

Lethbridge, Alta.—A school to cost $50,000 for Saskatchewan S.D. No. 1,036, and Albert S.D. No. 1,753, will soon be erected if present plans go through. A. M. Jeffers, architect, 210 McLeod Bldg., Edmonton, is preparing the layout.

The Operators' Point of View

PLASTIC CEMENT

By C. F. Pye

I have increased my boiler efficiency fifty per cent., and one of the most effective things done to obtain such efficiency was to fill all the cracks in the boiler setting with plastic cement, and where the cracks were very large, or a brick was left out, the hole was filled with a thick mixture of plastic cement and mineral wool.

All cracks, such as the outlines of iron work, such as clean-out door and boiler front were well filled with plastic cement. The holes in the settings where the blow down, blow off, feed pipes etc., where they enter the settings were filled with a very thick mixture so that the heat will not soften the cement before it sets.

After this was done, I noticed that I had a much better draft, which meant better combustion and cleaner flues.

Then one day my arch over the fire doors fell down, and left a hole large enough to let a brick fall through on its flat side. This being a very busy day I could not keep up steam, so I tried plastic cement and mineral wool in the following manner: I cleaned all the remaining brick of their soot and ashes, and with an old paint brush I painted the cleaned brick all around the hole, this making a good adhesive surface for the patch. Then I laid a piece of stiff asbestos paper across the hole, and applied a one inch coat of loose mineral wool over the paper, then a very thick mixture of plastic cement and mineral wool.

The heat then softened the binder and allowed the free mineral wool that was applied on the paper, to become saturated with a good binder, that when later dries, and makes a splendid bridge and protecting the top part of the patch, which remains soft and pliable, and remains air tight.

A patch of this description has been in service for about five months and is in good condition; thus saving a cut-out boiler with all the involved losses; the losing of steam when most needed, and the price of a new arch, for at least until it could be conveniently replaced, and with no greater cost than one dollar in material, and half an hour in labor.

Similar repairs have been made when the fire has destroyed the brick, and they all hold good.

Another splendid place for it is in the V-shape, that is, where the boiler shell meets the setting.

When repairing or building, the space ought to be filled a few inches with loose mineral wool then a coat of thick mixture of mineral wool and plastic cement. Then, as before, the cement gives off some of its oil, and causes the loose wool to bind tegether, protecting the top from the heat and allows the top part to adhere to the boiler on one side, and the setting of the other, thus making an air-tight joint, and allowing the boiler to expand freely.

This soft cement on top will catch any small, loose particles of mortar or brick that are always dropping off in the place mentioned, and prevent them from falling down in the bottom of the V-shape when the boiler is cooled, and causing the wall to be pushed further apart at the next heating.

The V-shape may be filled with a coat of cement, and a coat of dry wool alternately, each an inch thick for about seven inches. Then you can enjoy a good-looking boiler, setting free from cracks.

You can apply this mixture to the rear end where the setting meets the boiler above the flues in the combustion chamber.

This has caused me much trouble, and the company much fuel.

SHORT CUTS FOR ENGINEERS

The Editor,
The Power House.

The writer has had brought to his attention an advertisement for a set of engineering books recently placed on the market. The advertisement in question gives the following which purports to be an extract from one of the books:

"Why spend a ridiculous amount of time figuring horse power by this method (the method they all use)?

Rule: Multiply twice the mean effective pressure in pounds per square inch by length of stroke in feet, by area of piston in square inches and by number of revolutions per minute: divide this product by 33,000.

Firemen, Engineers and even professors waste time and mental effort with this out of date rule—Why not do it thus:

Rule 2: Multiply the decimal .000004 by diameter of piston in inches squared, by stroke in inches, by number of revolutions per minute and by mean effective pressure in pounds per square inch.

Either of the above rules give results accurate enough for practical purposes, and if anyone were making calculations of the horse power of different sized engines under different conditions every day or so, the second rule might save a little time.

The average operating engineer does not figure horse power more than once or twice a year or so, or if oftener it is generally the same engine over again for which he can calculate his own cylinders constant. With infrequent use as above such a rule as above would be forgotten between times of use, and unless a man has his book in his pocket he would likely be stuck for figuring horsepower, as no engineer can afford to cram his memory full of rules which he is not going to use more than once or twice a year.

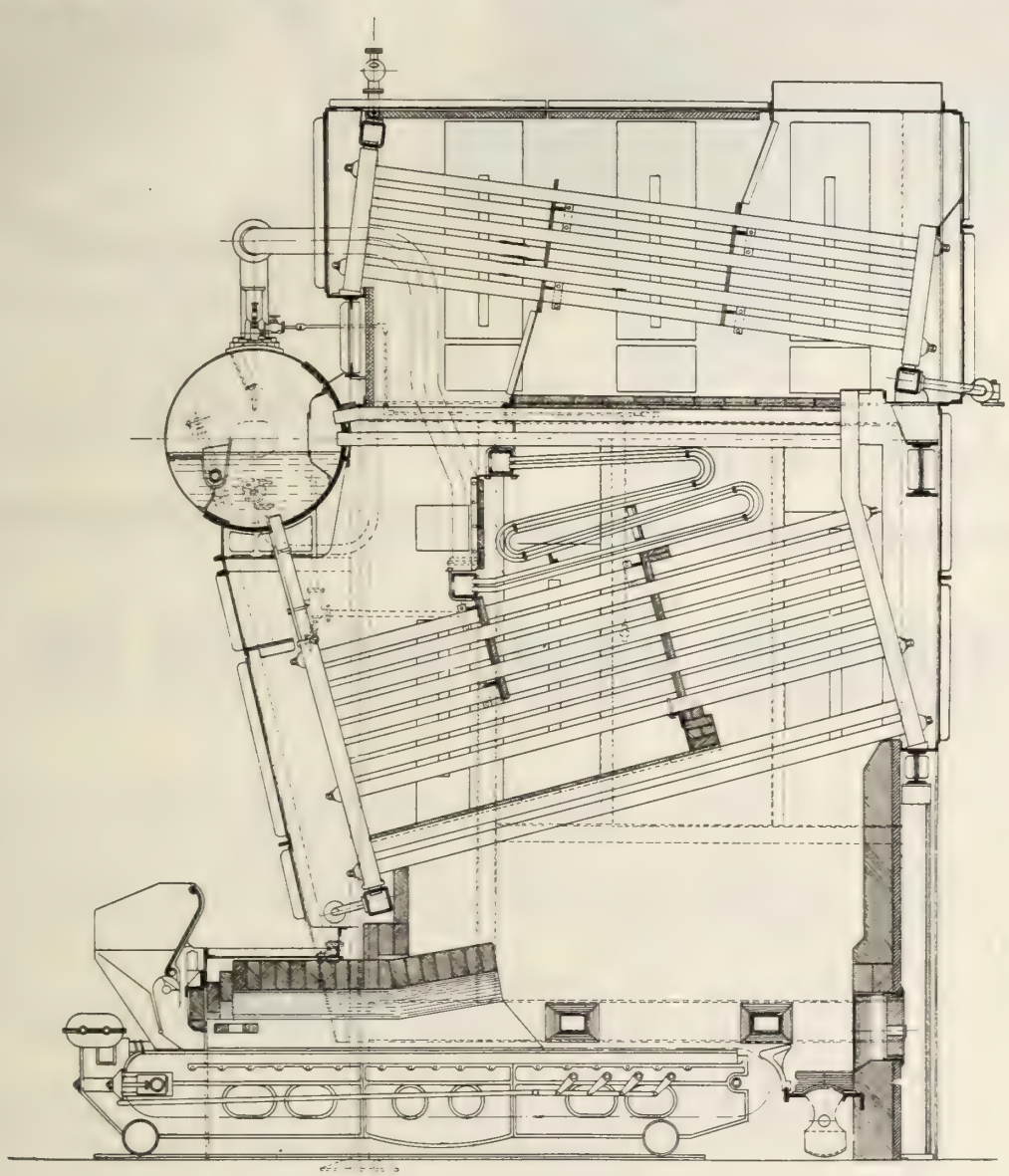
Any good textbook or hand book should give and explain the derivation of Rule No. 1 as given above, as that formula is derived from first principles. If any engineer once goes over this it is merely a matter of using a little common sense to develop the rule again without the use of books at any time without any tax on the memory. It seems to the writer, therefore, that such short-cuts as above should be discouraged, because their development from first principles is more complicated, and most people's memories fail at times, also most people do not carry textbooks on the job with them, so that when the time comes to use the shortcut, it can not be used.

The writer is not trying to knock the particular set of books referred to, but would like to impress on engineers the value of getting their knowledge from first principles and thus be able to develop formulas when needed instead of trying to remember a lot of facts and figures of which they do not know the full meaning.

Yours etc.
M. B. WATSON

The American Well Works, Aurora, Ill., have sent us Bulletins 130, 156, 157, 158, 159, and 160, dealing with their various lines of pumps for well purposes. The apparatus covered includes deep, well cylinders and accessories, deep well turbines, deep well power heads, deep well steam pumping engines, open impeller centrifugal pumps, double suction centrifugal pumps. Each bulletin describes and illustrates the particular apparatus named.

High Efficiency Boilers



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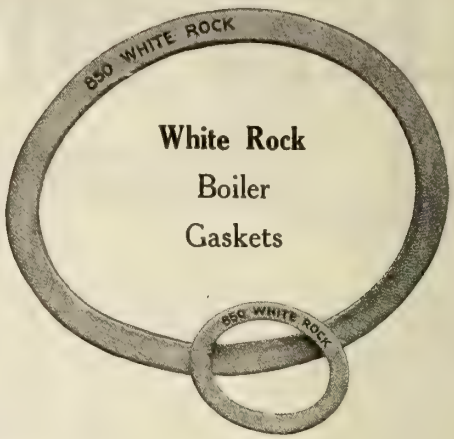

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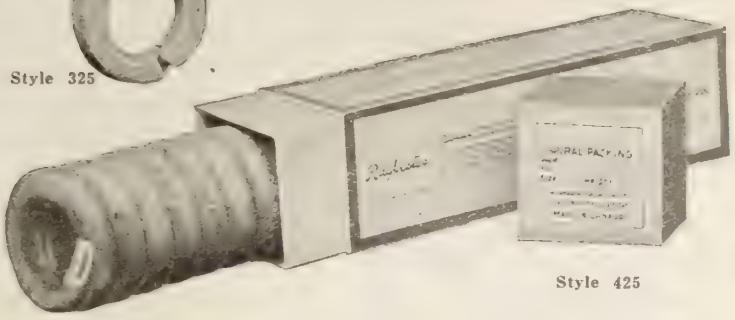

Style 425

Raybestos TWIST

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for small piston rods and valve stems

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A Striking Message

A STRIKING message to manufacturers of power-house equipment is derived from a letter written by a "Power House" reader in reply to a request for a criticism of the paper and for suggestions as to how it could be improved. Here is the letter:

"I believe Power House compares favorably with other power-house journals in many respects. One department I would like to see at least three times its present size is the selling section. Many of the ads. are from all-American U.S. firms but there must be many others, some of them with Canadian branches and agencies, who do not carry an advertisement in Power House. **This is a mistake on their part**, but for all I know to the contrary [illegible] of interest on [illegible] Power House ad. managers in getting after them. **It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages SO MUCH AS ON THE ADVERTISEMENT PAGES.**"

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WANTED—SITUATION AS GAS ENGINEER for producer or city gas, gasoline or kerosene engine. Preferably for small electric light plant, able to do own repairs, climb poles and do own wiring and take full charge. Apply Box 31821, Power House. p.2.h.

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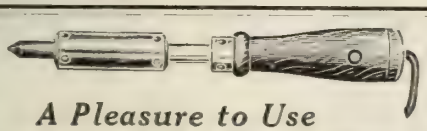

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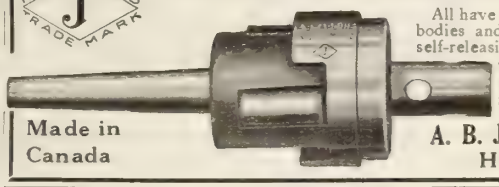

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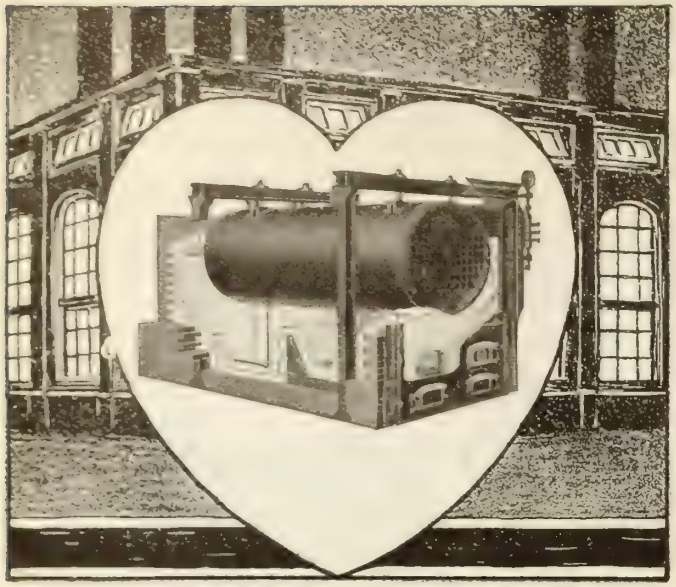

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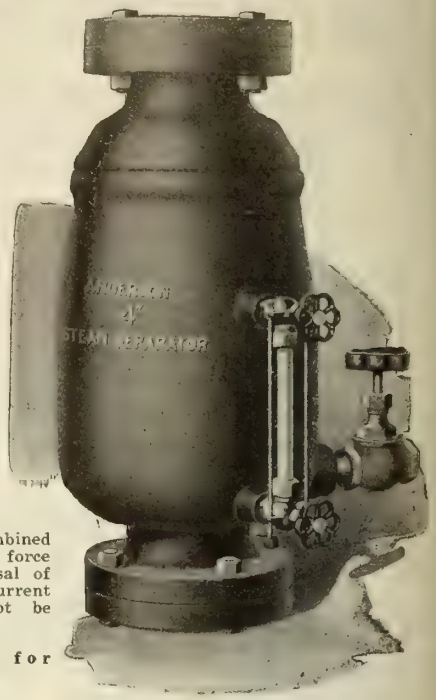

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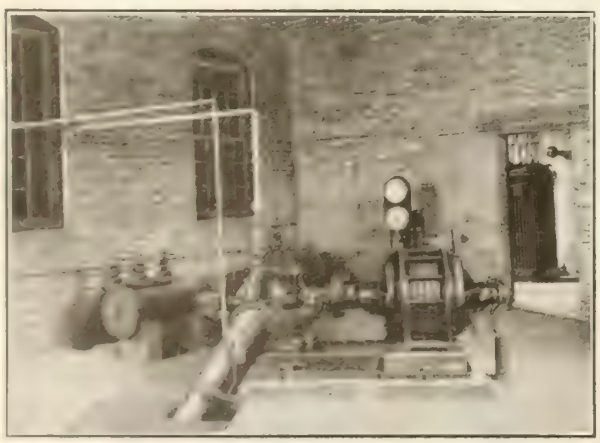

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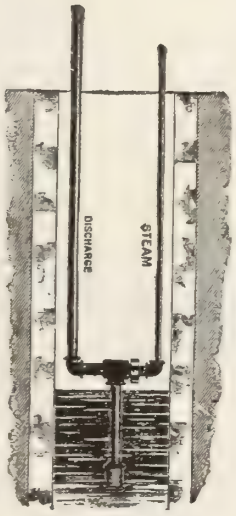

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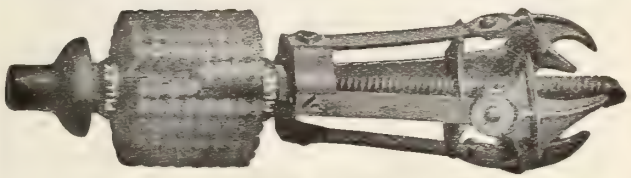

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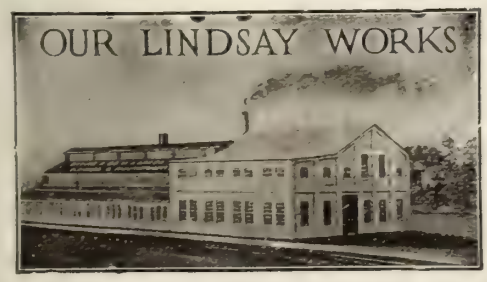

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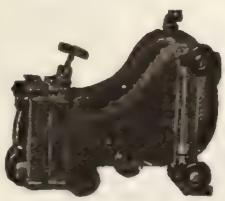

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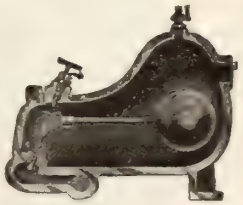

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[illegible] Co., Montreal.

CONDUITS
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CONDENSATION RECEIVER
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CONNECTIONS, FLANGED
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[illegible] Steel Co., Sherbrooke, Que.
[illegible]anks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.

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Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

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[illegible] Hagerstown, Md.

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Armstrong Cork & Insultaion Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

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Can. Fairbanks-Morse Co. Ltd., Montreal

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

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Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach., Co. Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Babcock Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox Ltd., Montreal

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

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Can. Fairbanks-Morse Co., Ltd., Montreal.

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Gutta Percha & Rubber Co., Ltd.

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Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

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Johns-Pratt Co., The, Hartford, Conn.

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York Manufacturing Co., York, Pa.
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Canadian Sirocco Co., Ltd., Windsor, Ont.

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Bowser Co., Ltd., S. F., Toronto, Ont.

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MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

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Jas. Morrison Brass Mfg., Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, ue.
MacGovern & Co., Inc., New York.

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Gelinas & Pennock, Reg'd, Montreal.
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Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

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MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co., of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg., Co., Toronto.

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Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
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Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont

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Leonard & Sons, Ltd., E. London, Ont.

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Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

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Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
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Goldie & McCulloch Co., Galt.

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Prantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

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Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F. Toronto, Can.

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Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

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Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
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Williams & Co., J. H., Brooklyn, N.Y.

EYE BOLTS

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Mason Regulator & Eng. Co., Ltd., The Montreal.
Sturtevant Co., B. F. Toronto, Can.

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Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

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Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
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Laurie & Lamb, Montreal.
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S. F. Bowser Co., Ltd., Toronto, Ont.

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Frick Co., Waynesboro, Franklin Co., Pa.
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Crane Limited, Montreal.

FITTINGS, MARINE
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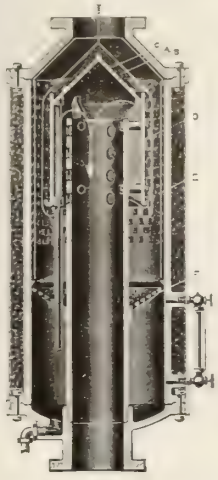

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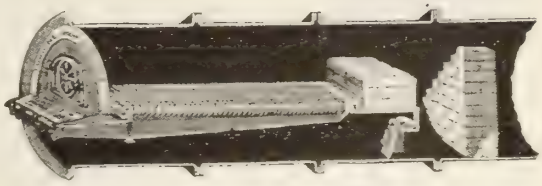

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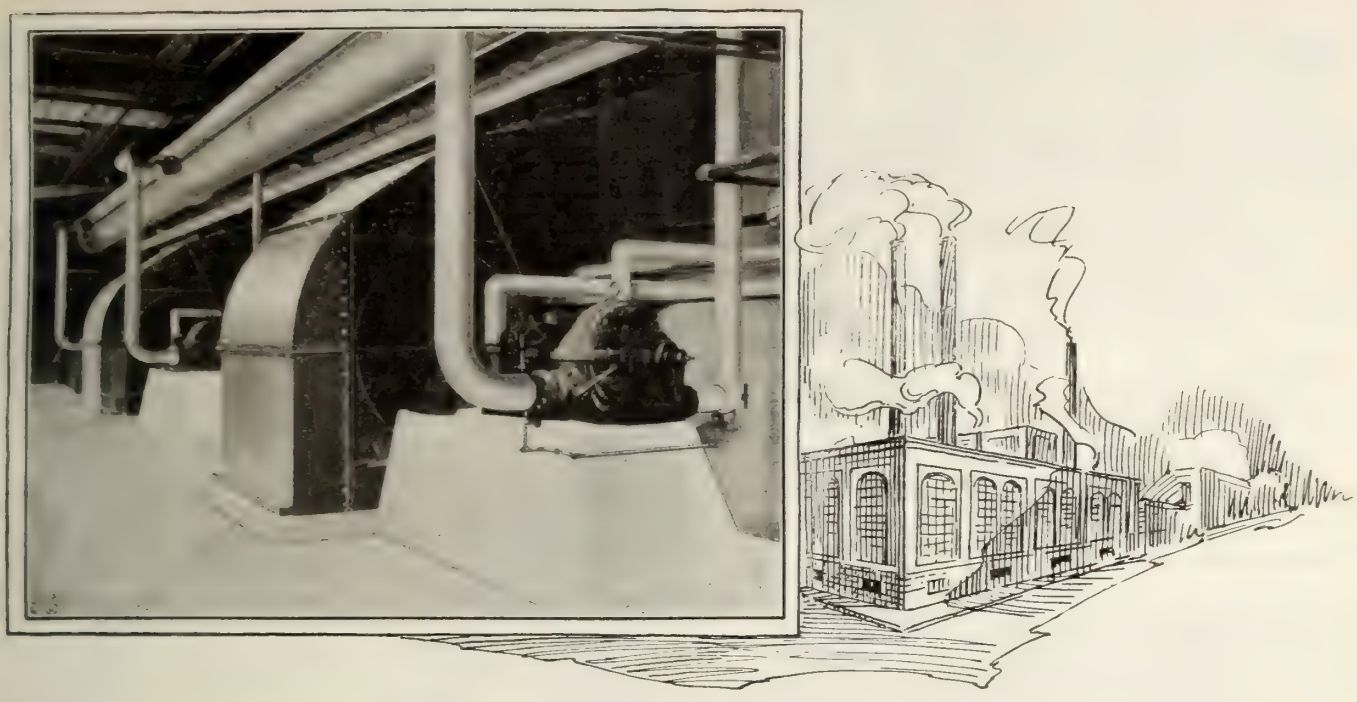

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Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

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Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply Ltd., Toronto.
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Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
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Canadian Steam Boiler & Equipment Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Shell Bar Boico Supply Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.

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Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
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W. R. Sexton Boiler Setting Co., Toronto
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American Steam Gauge & Valve Mfg., Co.
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Laurie & Lamb, Montreal

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Smart-Turner Machine Co., Ltd., Hamilton.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
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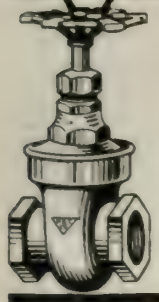

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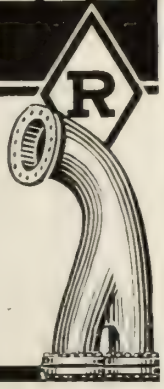

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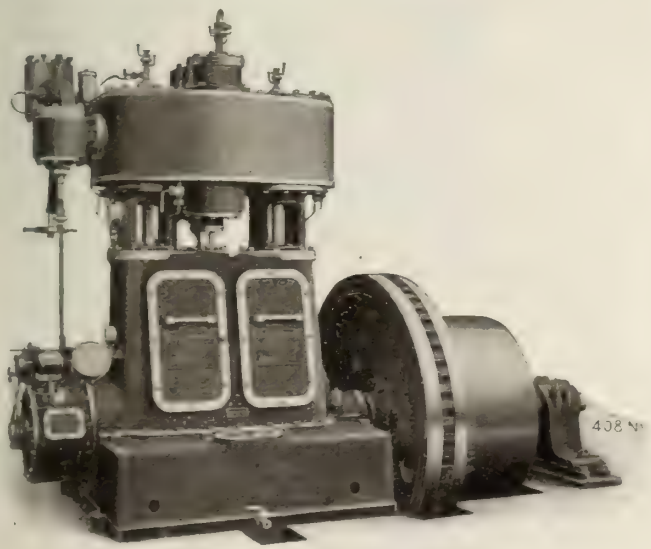

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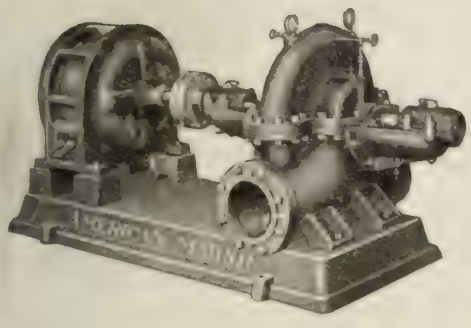

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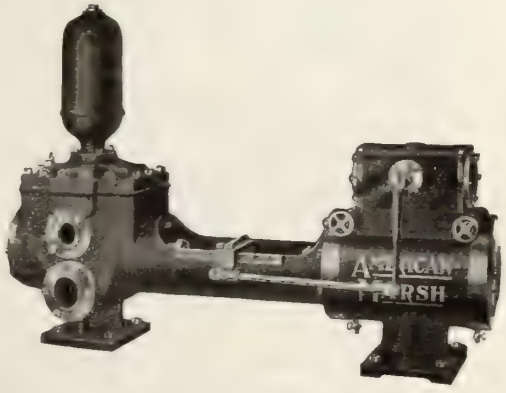

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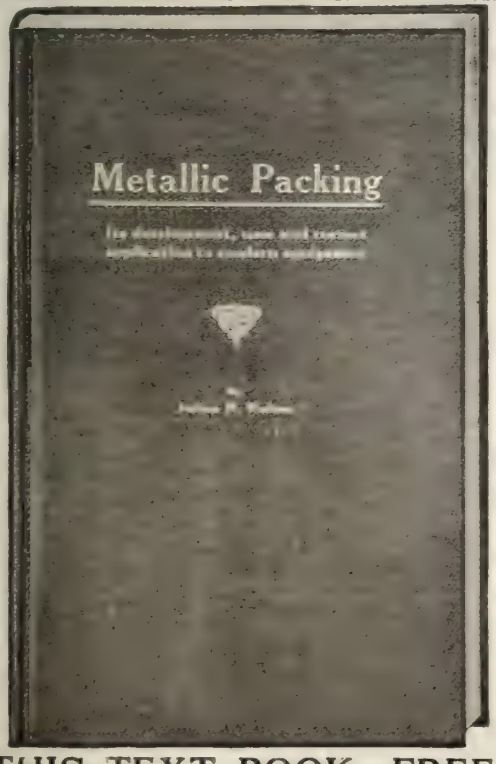

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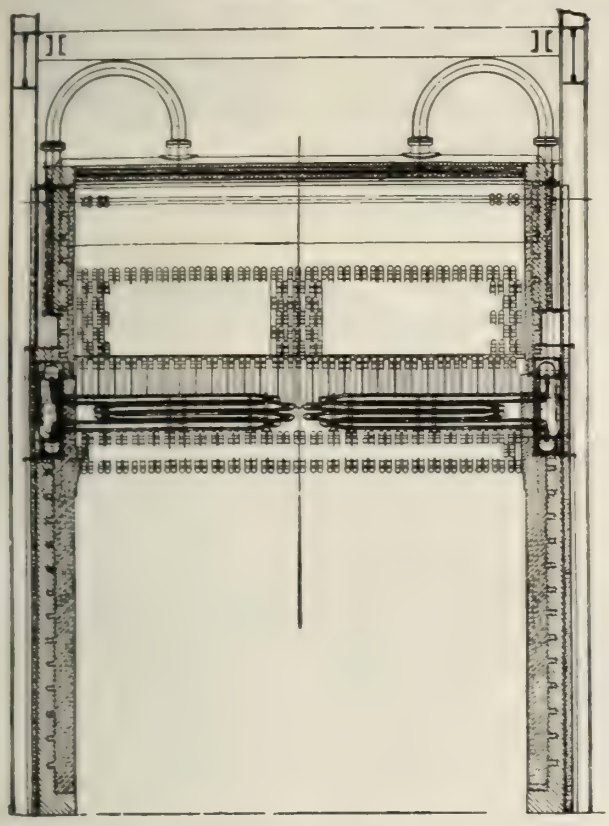

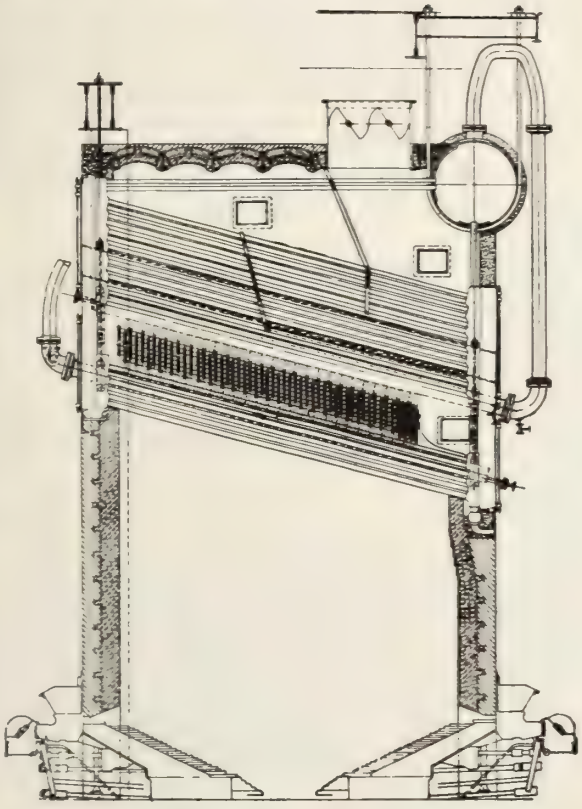

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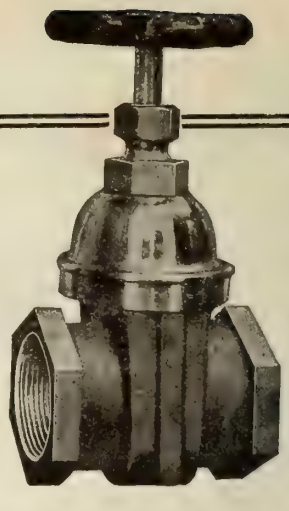

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The James Morrison Brass Mfg. Co., Limited

93-97 Adelaide St. West, TORONTO, ONT.

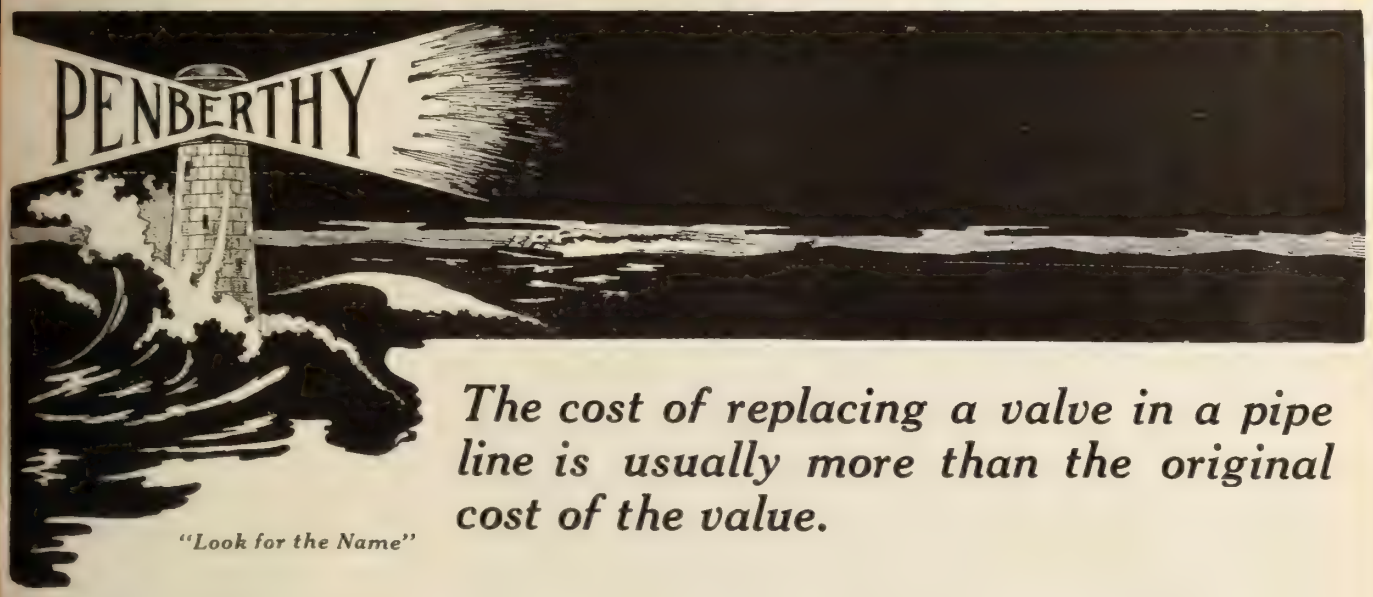
PRE-CONVENTION ISSUE

POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto
MONTREAL, WINNIPEG, VANCOUVER — LONDON, ENG.: 88 Fleet Street, E.C. — NEW YORK, BOSTON, CHICAGO

Vol. XV.—No. 12 — Publication Office, Toronto—June 20, 1922 — Published Semi-Monthly Canada, $2; U.S. $2.50 a year



"Look for the Name"

The cost of replacing a valve in a pipe line is usually more than the original cost of the value.

ALL PENBERTHY VALVES ARE GOVERNMENT APPROVED

Penberthy valves are made to wear longer —take more punishment and repair easier than most.

Composition Disc
Regrinding
Gate
Radiator

Send for Catalog

All Penberthy Valves
are of the
Outside Bonnet
Construction

The first radical improvement made in brass valves for many generations.

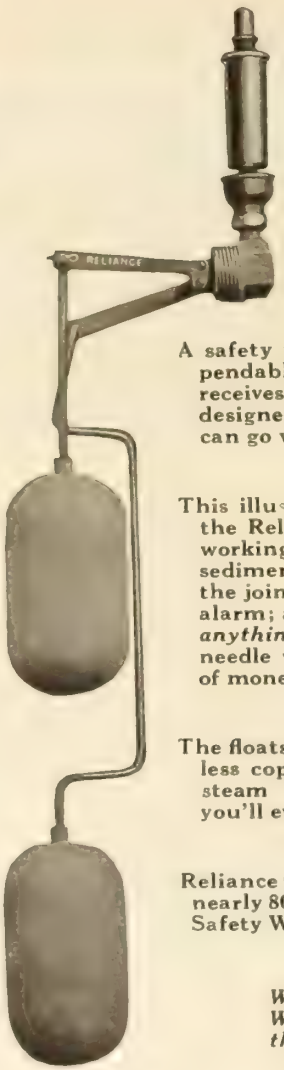
Penberthy Valves are recognized by leading engineers as representing the most modern and progressive ideas in

VALVE
CONSTRUCTION

MANUFACTURED BY
PENBERTHY INJECTOR CO., LIMITED, WINDSOR, ONT.

The original 35 years ago **R** Standard ever since

positive warning that the water in your boilers has reached a dangerous level



THE warning may be given by a single whistle, by a whistle for each alarm, by a whistle and an electric signal, or by an electric signal alone — whatever your plant requires.

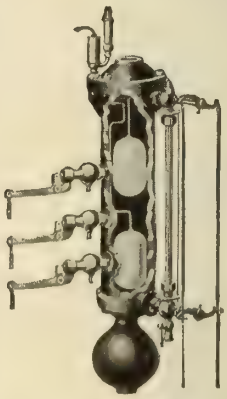
A safety water column must be absolutely dependable—*ALL* the time. Even though it receives only perfunctory care, it must be so designed and built that practically nothing can go wrong with it.

This illustration shows the vital mechanism of the Reliance high and low water alarm. All working parts are up out of the water; no sediment or foreign deposits can clog or stiffen the joints. There is a separate float for each alarm; and the low alarm float is so set that if *anything* happens to it the whistle blows. The needle valve which the levers operate is made of monel metal—you know what that means.

The floats are Reliance made of reinforced seamless copper, and every one factory tested to steam and water pressures far higher than you'll ever subject them.

Reliance Columns *are* dependable. The fact that nearly 80% of all the columns in use are Reliance Safety Water Columns is considerable evidence.

Write to us for full information. We are preparing a new catalog that will be ready soon.



Here is the complete column cut away to show the float mechanism. The cost of this safety device is so low and its service so important, that no boiler plant — one boiler or fifty—can afford to be without it.

Reliance

TRADE MARK
REG. IN U.S. PAT. OFF.

STEAM SPECIALTIES

THE RELIANCE GAUGE COLUMN COMPANY

5936 Carnegie Avenue, Cleveland, Ohio

Files Hand Stokers Getting Results

PANTHER RUBBER COMPANY, LIMITED

GENERAL OFFICES AND FACTORIES
SHERBROOKE, QUE.

SHERBROOKE, CANADA September 23, 1921.

The Waterous Engine Works Co. Ltd.,
Brantford, Ont.

Gentlemen:

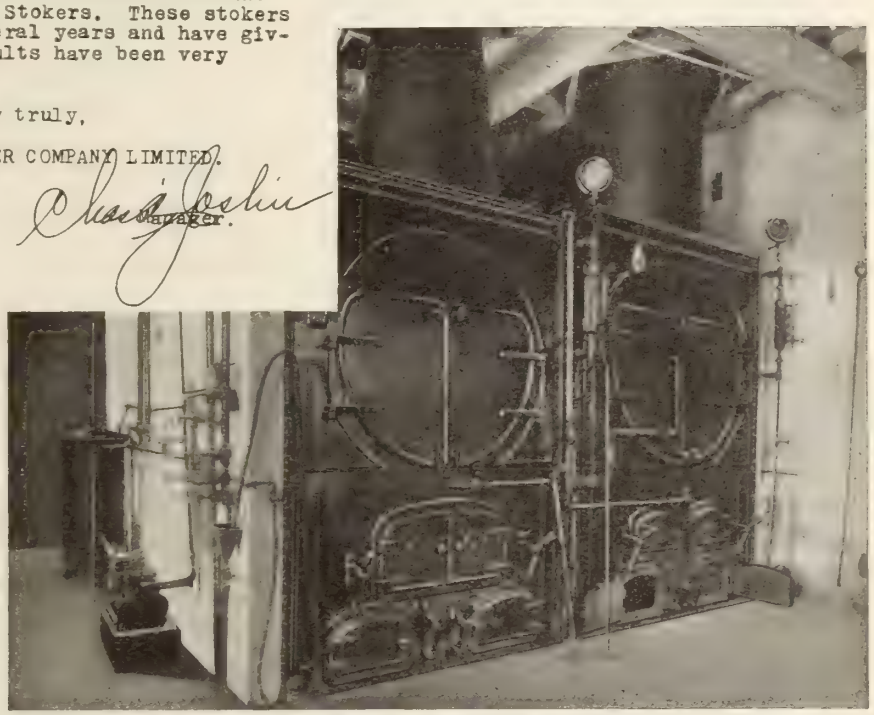
In reply to your letter of the 8th instant we have in our plant the Files Stokers. These stokers have been in operation for several years and have given excellent service. The results have been very satisfactory.

Yours very truly,

PANTHER RUBBER COMPANY LIMITED.

Manager.

CAJ/RMK



It is the uniform excellent service and general satisfaction that have caused progressive men to select **Files Stokers.** These are typical of the more complete data we have compiled:

One installation (3,600 H.P.) saved enough coal to pay for their stoker investment in five months.

A Files installation operated for five months continuously at an average rating of 223%—doubling their steam output.

Files stokers increased efficiency of one plant sufficiently high to warrant discontinuance of two out of eight boilers.

Here is a ready explanation of these achievements:—

1. **Complete volatilization of green coal, causing intensified combustion and smoke dissemination.**
2. **Correct distribution and proper proportion of air according to load carried.**
3. **Fuel bed continuously kept clean, uniform and rich.**

Given the opportunity we will be glad to present these facts for your complete satisfaction.

The Waterous Engine Works Company, Ltd.

Brantford, Ontario

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

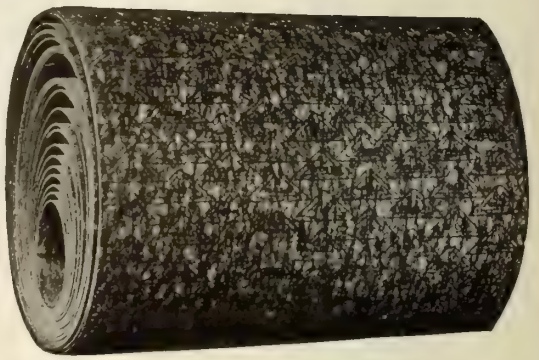
Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 1-15 Saunders Ave., **Toronto**

Sales Agents: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

For Tight Joints



Durabla compressed asbestos fibre sheet packing makes tight joints on steam, water, air, oil, ammonia and acids at all temperatures and pressures. Joints can be broken without injury to gaskets. It will not burn out, blow out, pulp at the joints; requires no following up and is not affected by vibration or condensation. Durabla Packing meets all conditions of shipping and storage.

Made in Canada by Canadian Durabla, Limited

and sold on a service basis by

The Canadian Fairbanks-Morse Co., Limited

DURABLA

The P.S. asks the G.M. about Vacations

When machinery is correctly lubricated with Imperial Lubricants and running without a hitch the Plant Superintendent doesn't have any difficulty in getting the General Manager to O.K. good vacation schedules for himself and the engineers

Trouble-free plant operation is the rule where Imperial Lubricants are used. You get a right grade of oil for every lubrication need. Quality is always strictly maintained and every rubbing friction surface is protected by a perfect oil film.

The experience of Imperial Lubrication experts is always at your service. Write to 56 Church St., Toronto.

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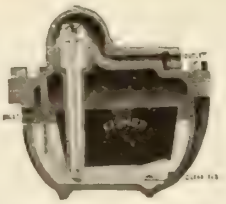
T-2787



Fisher Steam Trap (Type 33)

How to Cut Your Replacement Costs

When you are making repairs to your heating system you should ask yourself several questions—

"How long has this device been in operation?"
"Has it performed satisfactorily?"
"Has it required excessive repairs?"

If these questions are not answered favorably you should immediately install devices that will answer these questions satisfactorily next year and every year for years to come.

Fisher Steam Specialties have earned a reputation for long life, accuracy and economical operation. Engineers throughout the country rely on Fisher Specialties to help cut replacement costs.

FISHER STEAM TRAP
(Type 33)

will keep your steam lines absolutely free of all condensation. It insures your steam reaching its goal dry and hot. Extra large capacity — positive dumping action—monel metal valve and seat — permanent water seal against steam leakage.

FISHER REDUCING VALVE
(Type 10)

is a double-seated, positive acting valve. Sensitive—accurate — long-lasting—cannot hammer or stick. It can be equipped with different sizes of diaphragm to render exactly the service you require.

FISHER REDUCING VALVE
(Type 11-A)

is like Type 10, but built with expanded outlet which makes it possible to effect great economy in installation costs.

These are but a few of the complete Fisher Line. We have pressure regulators of various types and sizes to handle most any requirement.

"POWER PLANT SPECIALTIES" is a book full of interesting information about the Fisher Line. Write for it to-day.

The Fisher Governor Company

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Agencies in all principal Cities.

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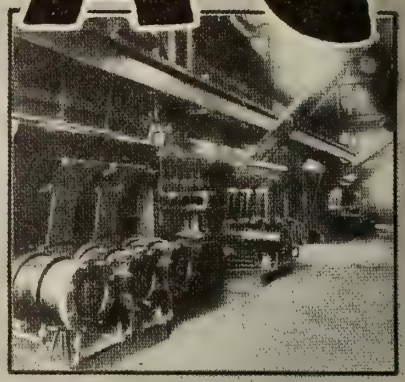
Jones "A-C"



High-Duty Stokers

—*duplicating "test runs" in daily service*

THE high efficiency of Jones "A-C" Stokers is not based on complications that could easily fail when most needed — nor on fine adjustments that would continually require expert attention. That is why their high efficiency and heavy overload capacity is just as apparent in yearly operation as in daily "test runs" conducted under expert guidance.

Jones "A-C" operating records prove that a stoker need not be complicated to fulfill the strictest requirements of high-duty service.

The simplicity of the Jones "A-C" coupled with correct design insures high efficiency, lowers first cost as well as installation cost, insures continuous operation, lowers upkeep and labor costs and reduces the number of repair parts necessary to be kept in stock.

The new "A-C" catalog illustrates and describes the simple design and rugged construction of the Jones "A-C." Ask for a copy of this thorough catalog.

Made in Canada

All Jones Stokers are made in Canada by Canadians and sold for Canadian money at par.

Under-Feed Stoker Co. of Canada, Ltd.
146 King Street West, Toronto

BRITISH COLUMBIA: E. A. Earle, Limited, 846 Hastings St. W., Vancouver, B. C.

ALBERTA AND WEST SASK.: Mr. J. Twomey, Camrose, Alberta.

QUEBEC AND MARITIME PROVS.: The Cleaton Co., (Canada), Ltd., 403 Southam Bldg., Montreal, Que.

MANITOBA AND EAST SASK.: W. W. Hicks, & Co., 567 Banning St., Winnipeg.

"It's a Jenkins Disc and that means Service!"

There is no better valve disc than Jenkins.

Perfected through more than fifty years of manufacturing skill and knowledge it gives the valve life and usefulness that are practically unlimited.

Jenkins Valves equipped with genuine Jenkins Valve Discs assure a trouble free valve service.

Know the genuine by the name "Jenkins" within a Diamond mark.

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Valve

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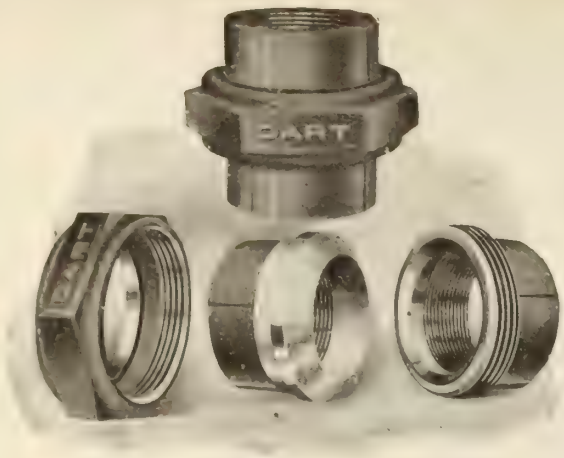


DART UNIONS

Never Loosen Up and Leak

"Dart" Efficiency—

Expansion, contraction or vibration have no effect on these Unions, because "Dart" parts are made of heavy malleable iron and bronze and are sufficiently strong to withstand extremely heavy service, no matter how severe.

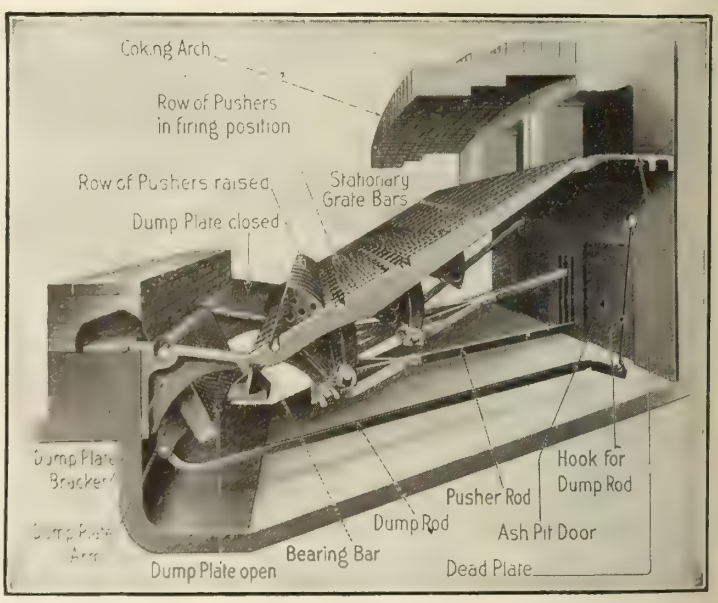
Sold by your Jobber.

Manufactured by Dart Union Co., Limited, Toronto

You need the National Stoker

Get away from inefficient hand stoking—without going in for costly mechanical stokers—come in between with the National Hand Fired Stoker which any "green" furnace man can be quickly taught to understand. Pusher rods at front of furnace operate successive banks of Pusher Grates, keeping the fuel moving downward—finally to the Dump Grates. Ensures proper progressive combustion. Any type of fuel can be used. No smoke. No fuel in combustion chamber. No ashes in flues. Increased boiler capacity. Can be installed under your present Boilers. Made here in St. Catharines and sold at a very moderate price.

Write for descriptive literature



Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

Detroit V-Type Stokers for dependable, efficient, and economical boiler operation in Public Buildings.

It is a principle of management of public buildings that the corridors, rooms and assembly halls must be adequately heated at all times, and that water, light and elevator service be continuously available.

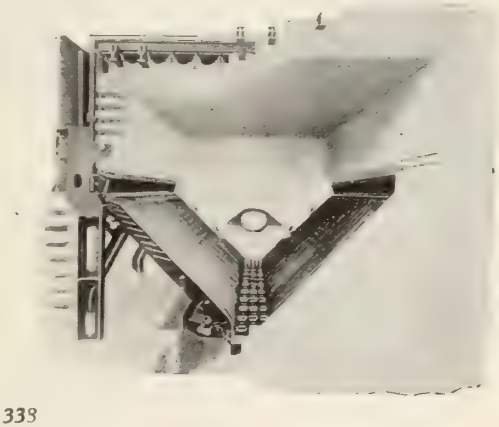
To secure this dependability special attention must be paid to boiler operation. Recognition of this fact by Engineers and Architects has led to the installation of Detroit V-Type Stokers in hundreds of public buildings.

Typical buildings equipped include:

Methodist Book and Publishing Co., Toronto, Ont
Toronto Housing Co. Toronto, On.
Mount Alto Sanitarium, Mount Alto, Pennsylvania
Municipal Hospital, Pittsburgh, Pennsylvania
Pennsylvania State Hospital, Warren, Pennsylvania
Ohio Valley General Hospital, Wheeling, West Virginia
Secor Hotel, Toledo, Ohio
U. S. Naval Hospital, Reservation, Brooklyn, New York
Broadway Armory, Chicago, Illinois
Central Y. M. C. A., Cleveland, Ohio
Detroit Public Library, Detroit, Michigan
Eastman School of Music, Rochester, New York
Masonic Homes, Elizabethtown, Pennsylvania
Masonic Temple, Pittsburgh, Pennsylvania
Michigan Agricultural College, East Lansing, Michigan
Monroe County Court House, Rochester, New York
Monroe County Penitentiary, Rochester, New York
St. Louis Central Library, St. Louis, Missouri
Wisconsin State Prison, Waupun, Wisconsin
Tuskegee Institute, Tuskegee, Alabama

Detroit V-Type Stokers are a profitable investment because with them: [a] average overall boiler efficiencies of 70-75 percent may be maintained, [b] one man can handle up to 1200 H. P. of boilers, [c] cheaper grades of fuel can be burned than with hand firing.

On every score your boilers should be equipped with Detroit Stokers. Remember, there is a type for every purpose—V-Type Overfeed for natural draft—Single Retort Underfeed for forced draft with boilers developing up to 300-400 H. P.—Multiple Retort Underfeed for large boilers.



Ask for Bulletin 338

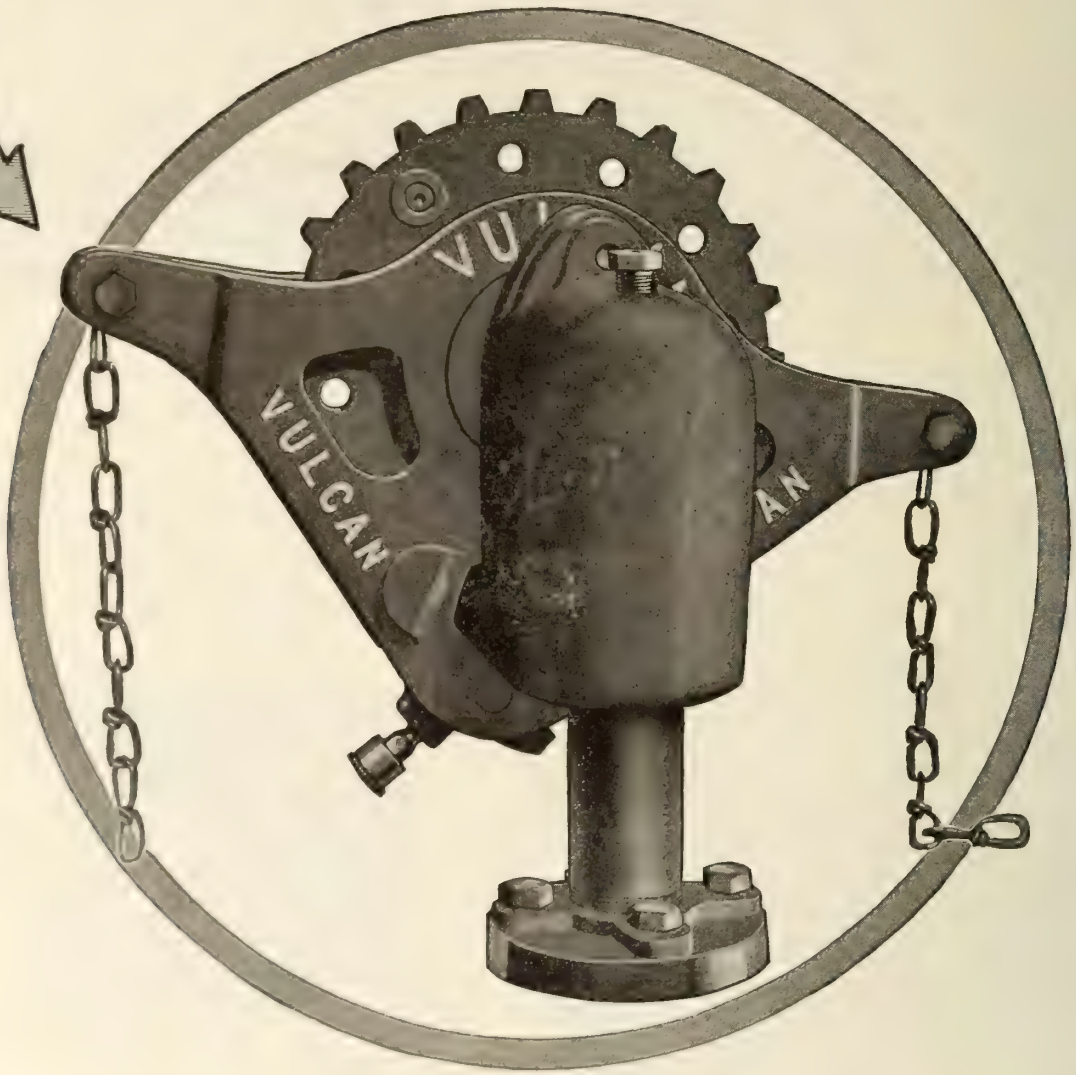
DETROIT STOKER COMPANY

Underfeed Forced Draft and Overfeed Natural Draft Stokers

338 GENERAL MOTORS BLDG. DETROIT, MICHIGAN

SAVE FUEL "DETROIT V TYPE STOKER" AND LABOR

Introducing the



The Vulcan Ratchet Operating Head

Insuring "step-by-step" rotation of soot cleaner element
and more THOROUGH soot removal than ever

Newest and Most Advanced Principle in Soot Cleaner Operation

The Vulcan Soot Cleaner Company is pleased to announce what it is convinced is the most advanced principle in soot cleaner design and operation so far offered to the power plant engineers of America.

This new principle is embodied in the new VULCAN RATCHET OPERATING HEAD, illustrated on the opposite page.

For many years a small percentage of operators of soot cleaners have complained that their cleaners did not thoroughly remove the soot accumulations. In a majority of cases, investigation disclosed the fact that the cleaning elements either were being operated too fast, or rotated by careless workmen through only a portion of the entire sweep, thus preventing the cleaner from doing its proper work, through failure to give the steam jets time enough thoroughly to clean the tube surfaces.

The new VULCAN RATCHET OPERATING HEAD is designed to take the mechanical operation of the cleaning element entirely out of the hands of the operator! The new Head is so constructed that when the operator pulls the chain the element is rotated only a short distance, and can be turned no farther until the ratchet frame has been returned to its original position. Then, and only then, a pull on the chain causes the element to rotate another space. Between the lulls in operating the new Head, the steam jets have an opportunity to concentrate upon a definite section of the tube surface for a length of time sufficient to insure a thorough removal of the soot. When the complete arc of rotation has been attained in one direction (which is limited by special "stops" especially set for the purpose), the mechanism' AUTOMATICALLY reverses itself and the cleaning element moves back in the same manner through the same arc. Any soot that may have re-deposited after the first rotation is completely removed on the backward travel.

Since the first requirement of every soot cleaner is to remove the soot, it will be obvious that this purpose is accomplished by the new VULCAN RATCHET OPERATING HEAD, no matter who operates the cleaner or how careless and inefficient a workman may be.

Special Features of the New Vulcan Head

There are five principal features to the new VULCAN RATCHET HEAD, which are worthy of consideration. These are:

(1) It absolutely prevents the man operating it from neglecting any part of the complete sweep of the cleaning element;

(2) It substitutes a uniform rate of speed of rotation, in a step-by-step movement, controlled almost entirely by the Head itself, in place of the old, irregular, uncertain rate controlled by the whim of the operator and his desire to get through with the job;

(3) It assures a considerable saving in quantity of steam used, because the operator knows that he has to make the sweep only once in each direction, and can stop when that has been accomplished;

(4) It provides the operator with a clearly defined task, instead of a vague and indefinite one;

(5) Above all, it entirely eliminates wrong methods of soot cleaning, and is an assurance of more satisfactory cleaning results.

The new Head is remarkably simple and strong. Its action is positive and sure. There is not a part to slip out of place, and thereby throw the whole device out of action. The chain is securely riveted to the ends of the ratchet frame and no amount of pulling or jerking will tear it loose.

This new Head is operated INDEPENDENTLY OF THE VALVE. Therefore, should either accidentally fail, the whole Cleaner System is NOT put out of commission while repairs are being made. The value of a soot cleaner depends upon its usefulness. If the temporary failure of one cleaning element means that the whole system is out of use until that one element has been repaired, clearly the real value of the Cleaner is seriously impaired.

A special Bulletin, thoroughly illustrating and describing the new VULCAN RATCHET OPERATING HEAD is now in course of preparation. If interested in this newest principle in soot cleaner operation, ask to be put on the list to receive BULLETIN No. 549 when it is ready for distribution. ***Meanwhile, upon request, our nearest representative will gladly call and demonstrate the new head at your office.***

The VULCAN SOOT CLEANER COMPANY

MAIN OFFICE DU-BOIS PA OFFICES IN THIRTY CITIES

WINNIPEG
William W Hicks & Co.
567 Banning St.

MONTREAL
Beveridge Supply Co., Ltd.

TORONTO
Green's Economiser. Ltd.,
Kent Building

P&H WROUGHT PIPE BENDS
AND FLANGED PIPE JOINTS
ALL KINDS AND SIZES UP TO 10" DIAMETER
MADE IN CANADA BY
PAGE-HERSEY TUBES, LIMITED
Head Office: 100 CHURCH STREET, TORONTO, ONT.

Jamison

HEAVY DUTY
Cold Storage Doors
Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
(Formerly Jones Cold Store Co.)
HAGERSTOWN - MARYLAND, U.S.A

YORK Ice Making & Refrigerating **MACHINERY**

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO., LIMITED

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R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

THOMSON-GORDON LIMITED

ENGINE PACKINGS

HAMILTON ONTARIO

2

Tycos temperature instruments

Three distinct types—Indicating, Recording, Controlling. In them is the direct solution of your temperature problems.

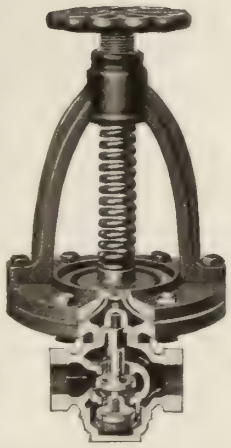
Our catalogues should be in your files for instant reference.

Taylor Instrument Companies
110-112 Church Street, Toronto
Theres a *Tycos* and *Taylor* temperature instrument for every purpose

826

CURTIS ENGINEERING SPECIALTIES

Comprise a line of devices that have stood the test of years for the utmost in efficiency. They are built for dependable and enduring service. Scrupulous care in the selection of material and in construction, with adherence to the highest engineering standards, have won them a commanding position. The



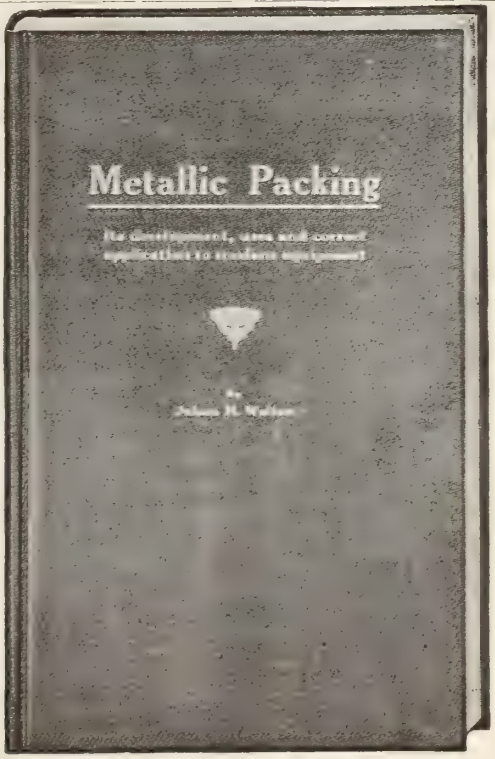
CURTIS WATER-PRESSURE REGULATOR

will deliver water into service pipes at any desired pressure, regardless of any fluctuations of outside pressure.

Trouble with rust or clogging with sediment is prevented. Waste of water in domestic use by flying or spattering is avoided by the reduced pressure. This also prevents water hammer or concussion and prevents wear and tear on all packings and seats in valves and faucets, thus eliminating frequent plumbing bills. Adapted for use in pulp and paper mills, hotels, public buildings and dwelling houses. For ¾ in. to 2½ in. pipe, screwed. For 3 in. to 8 in. pipe flanged.

The Curtis Line of Steam Specialties contains many other notable devices. They are fully described in our No. 50 catalogue. Write for a copy.

JULIAN D'ESTE COMPANY
26 Canal Street, Boston, 14, Mass.



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FLEXIBLE METALLIC PACKING CO.
WINDSOR - CANADA

AGENTS:
R. C. Miller Oil & Supply Co., Montreal.
H. E. CARMAN, 234 Cordova St., Vancouver, B.C.

The CAMBRIDGE PORTABLE CO_2 and Temperature Indicator

Weight — 14 lbs.
Size — 13 x 7 x 5½ ins.

Demonstration on Request

WITH this instrument, both the temperature and percentage of CO_2 in the flue gases can be indicated on the one instrument, the time lag being practically negligible.

The instrument is very portable and is complete in itself. In operation it is exceedingly simple, no chemicals being required; the results are reliable and it is always ready for immediate use. There is nothing to get out of order. It is particularly suitable for Consulting and Inspecting Engineers, also for large power plants as a test instrument to check permanent installations.

Made by THE CAMBRIDGE AND PAUL INSTRUMENT CO., LTD., LONDON AND CAMBRIDGE, ENGLAND.

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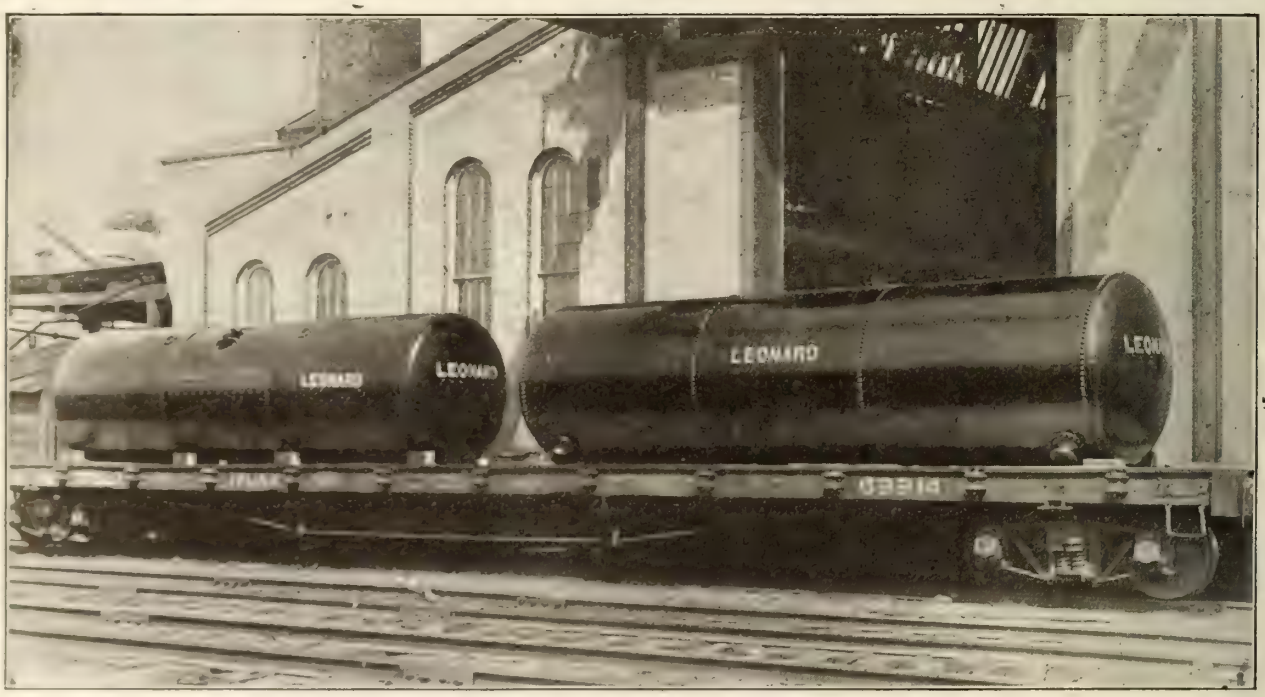


Two 72 Inch x 24 Ft. Pressure Tanks
E. LEONARD & SONS, LIMITED
Head Office and Works: London, Canada. Branches from Coast to Coast
Established 1834

LEONARD

Your Belting Should Be "Oak Tanned"

YEARS ago, the process of Oak Tanning was a jealously guarded secret in England. To-day, it is general knowledge among experts in all parts of the world, although Oak Tanning is acknowledged, without question, as superior to any other process, it is a slow —very slow—process and is not used generally on account of the expense entailed.

Since D. K. McLaren Belting has been made, however, every inch has been subjected to this Long-Time Genuine British Oak Tanning. It is this process, indeed, that not only adds to the original toughness of the hide, but imparts that wonderful flexibility and stretchless quality that has established for D. K. McLaren's Belting a world-wide reputation for Dependability.

In addition to this, however, it should be borne in mind that only the back—the toughest part—of hides selected by experts is used in manufacture.

The Oak Leaf is your guarantee that you are getting Genuine British Oak Tanned Belting. Users of experience know that it is worth while to make sure the Oak Leaf is on every length of Belting they buy. They know that it means real "service on the pulley" and the utmost efficiency even under adverse conditions. The Oak Leaf tells them that every inch has been put to the severest tests before leaving our factory.

Truly, D. K. McLaren's Belting is the royal road from the source of power to the pulley, for it delivers power with the least loss and gives a minimum of trouble doing it.

D·K·McLAREN LIMITED

Head Office and Factory:

351 St. James St., Montreal, P.Q.

Toronto, Ont.—194 King St. W.
St. John, N.B.—90 Germain St.
Vancouver, B.C.—Gormans, Ltd., 1158 Homer St.
Edmonton, Alta.—Gormans, Ltd.
Calgary, Alta.—Gormans, Ltd.

Style 103

Pack all Flange Joints with

Raybestos JOINTING

and they will not leak, burn or blow out

This is the Jointing that will give you real service on all pipe lines.

It is made from long Canadian Asbestos fibre, compressed under immense pressure, It has given complete satisfaction under gas temperature of 700 deg. and 1,000 deg. F., under hydraulic pressure of 4,000 lbs. per square inch, under steam pressure of 300 lbs. and 625 deg. F. superheat.

Standardize on one Sheet Packing for all flange requirements. Specify Raybestos always—whether for Engines, Pumps, Air Compressors, Ammonia Compressors or Gas Engines.

"They Wear Longest"

A Complete Line

RAYBESTOS JOINTING
RAYBESTOS TWIST
RAYBESTOS DISCS
REDBLAC SHEET PACKING

THE CANADIAN RAYBESTOS COMPANY,

Style 550

Pack all Valve Stems with

Raybestos TWIST

and you will not have to pack them so often

Made from long-fibre silky asbestos and thoroughly lubricated with high grade mineral oils and graphites. Will not harden or dry out.

Recommended for use in any plant—engine room—machine shop—garage—ship—dry-dock—laundry—plumbing shops—steam fitters. It will pack all styles of globe angle and stop valves—small piston rods—small pump rods—radiators. Used for water, steam, air, etc.

This twist is made from individual treated strands of asbestos twisted into ⅛ inch roves, then retwisted, using ⅛ inch roves, into larger sizes of finished packing.

Engineers can take large size, we will say ½ inch, and use for stem requiring ½ inch packing, or can untwist and take smaller strands for ¼ inch or 3-16 inch needs.

of Better Packing

RAYBESTOS GASKETS
RAYBESTOS SPIRAL PACKING
RAYBESTOS RING PACKINGS
RAYBESTOS GASKET TAPE

Sold by
MINE, MILL and MARINE
Supply Jobbers

LIMITED, Peterborough, Ontario, Canada

DEARBORN
Feed Water Treatments

DEARBORN FEED WATER TREATMENTS are scientifically prepared in accordance with analyses of individual boiler feed waters, to offset the detrimental elements found therein which cause scale, pitting, corrosion or foaming.

The services of our engineering experts are always at your command and analyses are made free of charge.

NO-OX-ID
IRON + OX = RUST
TRADE MARK

DEARBORN NO-OX-ID is an odorless and non-poisonous preparation, which, when applied to iron or steel, will absolutely protect them from the rust-producing elements in the atmosphere.

NO-OX-ID will also resist the direct action of acids or acid fumes on metals.

NO-OX-ID will not gum, crack, peel nor injure metal in any way.

Made in Canada

DEARBORN CHEMICAL COMPANY OF CANADA, LIMITED

2454-2464 Dundas Street West - - Toronto, Ontario

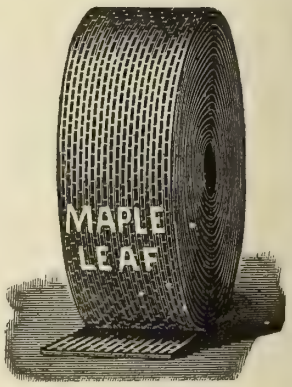
Dominion Belting Company, Limited

Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



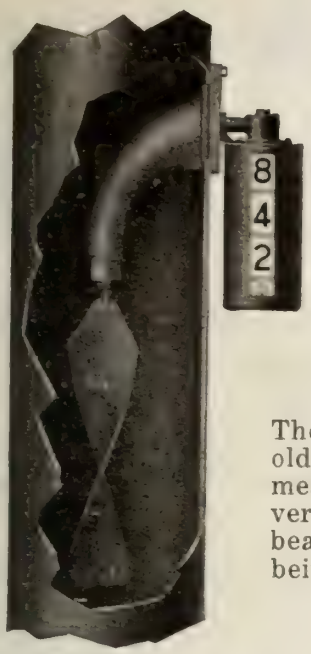
"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility.

DOMINION BELTING CO., Ltd., Hamilton, Canada - Quebec Branch: 51 Duluth Bldg., Montreal



A Boon to the Boiler Room

At a distance of 50 feet or more you can read the amount of coal fed each stoker hopper in unmistakable large black letters, after you equip all chutes with the

BAILEY METER

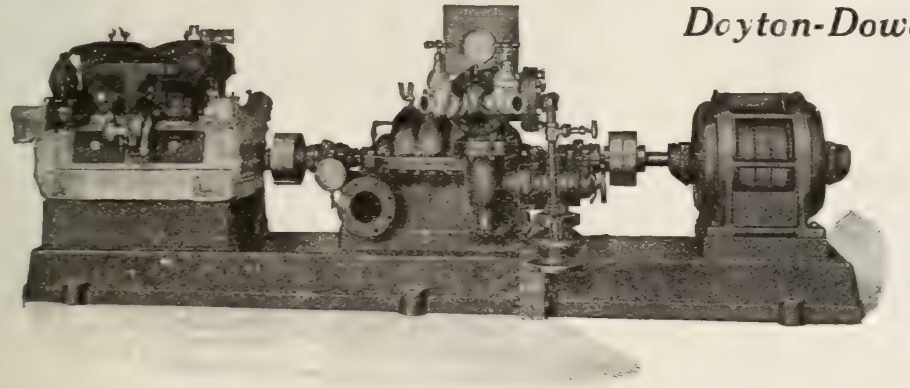
FOR COAL

The Bailey Meter for coal is a newly perfected development of an old principle which has established a remarkable accuracy in the measurement of coal. The vane is suspended within any part of a vertical run of coal chute, from a specially designed universal ball-bearing—the ball bearing being entirely protected. The counter being illuminated may be read at a long distance.

Bulletin No. 220 gives full details of the Bailey Meter for granular materials. May we send it?

BAILEY METER COMPANY, LIMITED

177 Delorimier Ave., MONTREAL, Que.



Doyton-Dowd Centrifugal Fire Pump

Arranged with dual drive consisting of electric motor and auxiliary gasoline engine. Capacity 500 gallons against a head of 100 lbs., speed 1450 R.P.M.

DAYTON-DOWD Fire Pumps

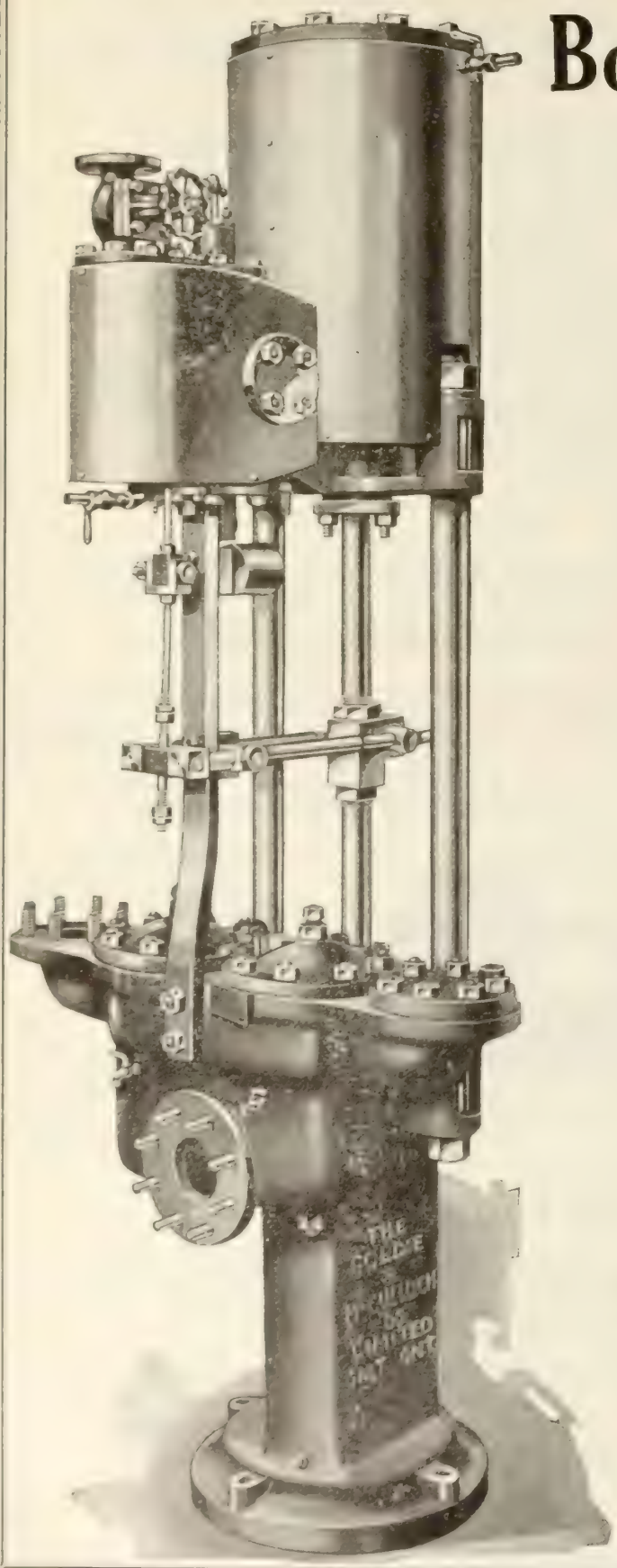
This Double Drive Fire Pump is a convenient method of installation and affords perfect dependability in case of failure of the electric or steam power. It consists of an electric motor or turbine and a gasoline engine, one mounted on each side of the fire pump and constitutes a most reliable standby to meet any emergency.

The installation is approved by the Canadian Board of Fire Underwriters. Write for bulletins of Dayton-Dowd Pumps for every service.

THE ARTHUR S. LEITCH COMPANY Limited

1001-2 Kent Bldg. **Toronto, Ontario**

Vertical Simplex Double Acting Boiler Feed Pumps



Reliable, Economical and Highly Efficient

THESE Pumps are designed and built to meet the requirements of the modern power plant.

Their slow steady speed gives a very high efficiency. Actual tests showing 95% in the water end as against 70% in a horizontal pump, with both pumps working under similar conditions.

In the Vertical Simplex Pumps the pilot or timing valve also acts as a cut-off valve, allowing steam to be used expansively and making possible the slowing down of movement at end of stroke.

You incur no obligation by consulting with our Engineering Department. We shall be glad to supply more detailed information on request.

Bilge and Ballast or Low Duty Pumps

These pumps are of the same general design as the Vertical Boiler Feed Pumps, but are primarily intended for discharging much larger volumes of water against low heads or pressures.

The Goldie & McCulloch Co., Limited

Galt, Ont., Canada

Branches and Agencies

Toronto Office—1101-2 Bank of Hamilton Bldg.; Western Branch—248 McDermot Ave., Winnipeg, Man.; Quebec Agents—Ross & Greig, 400 St. James St., Montreal, Que.; B. C. Agents—Robt. Hamilton & Co., Bank of Nova Scotia Bldg., Vancouver, B. C.

POWER HOUSE

Members of the Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Kitchener Is the Convention City

The Thirty-Third Annual Convention of the Canadian Association of Stationary Engineers Will be Held on June 27-28-29—An Interesting Programme Has Been Arranged, Both for Business and Pleasure.

IT SCARCELY seems a year since exhibitors and delegates were congratulating each other on the wonderfully successful convention just concluded at Ottawa. Well, it is perhaps just a little short of a year, but only a matter of a week. On June 27th, 28th and 29th the C. A. S. E. will hold the annual convention at Kitchener, and the prospects are for a bumper gathering of delegates and exhibitors, not forgetting the visitors.

Old time members of the Canadian Association of Stationary Engineers, have pleasant recollections of conventions held in other days, when the town was called Berlin. Some of these old boys will close one eye and look very mysterious and wise when these times are recalled, and they can tell stories, if so minded, of some nights when revelry stole abroad.

Well, it is hard to tell what may happen at a convention, and perhaps some of them will find a way to raise the spirits of departed days. In these days of spiritualism anything is possible. Did not even some of our staid and respectable M.P.P.'s manage to stage a party without getting into trouble? Surely an engineer is as clever as an M.P.P. If he were not, there would be a number of manufacturing plants going out of business before long.

A Fitting Spot

The town of Kitchener is without doubt as good a town as could be found to hold a convention of power plant engineers, and an exhibition of power plant apparatus. It is a manufacturing town in a large way. The first thing one sees on entering and the last on leaving is a manufacturing plant of some kind. There are three principal lines of endeavor, namely, furniture, shoes, and rubber products, and some of the rubber factories are well worth a visit. Not only are they worth looking over, but they invite one to do so, the only formality required being the issuing of a pass in the office.

Kitchener, besides being a manufacturing town, is a town of homes. Nearly everybody in the place owns his own home, and the majority of them are set in spacious grounds. In this respect they contrast very favorably with some more pretentious homes in other cities, which seem to be pining for breathing space. A story is told of a visitor to Kitchener, who, after being driven all over the town, up one residential street after another, finally arrived back at his hotel. His guide asked him how he liked the city, and the reply was "Fine, but where do the working people live?" When he discovered that he had been viewing where the working people lived he was a much astonished visitor.

The Dominion Tire Plant

One of the largest plants in the city is that of the Dominion Tire, just a little distance out of the general manufacturing district, but within easy access either by walking or street car from the main street. It is a handsome building, and stands in beautifully-kept grounds. The power plant will be found interesting from the point of view of the visiting engineers, and those wishing to see through it can arrange to do so, by request.

The power plant is primarily used to supply steam for process work, although there are also a number of steam auxiliaries such as air compressors and hydraulic pressure pumps, with of course, the usual feed pump arrangements. In case of emergency there is also installed a 750 k. w. turbo generator and this has been called into service on several occasions during the past winter.

The boiler plant consists of B. & W. boilers double drum 250 h.p. each, and two Goldie & McCulloch water tube boilers of 330 h. p. each, making a total of 1,660 boiler horse power. They are all fitted with Jones' underfeed stokers, while there is a complete set of Republic Co. recorders and indicators, the indicators being mounted on the boiler fronts where the firemen can see them at any moment. There is a water softening plant of sufficient capacity to supply all the boilers, and this has had a very beneficial effect since its installation in eliminating shut downs for cleaning purposes, as well as increasing the efficiency of the plant by reason of preserving clean heating surfaces.

The engine room contains the air com-

VIEW OF POWER PLANT DOMINION TIRE SYSTEMS
Building to left of stack is boiler room, and to the right is the water softening plant and compressor and pump rooms.

pressors for supplying air to the factory for process work, and the hydraulic pumps for the presses, etc., are also located in this room. There is an interesting battery of recording instruments, in connection with the boiler room. An interesting little kink was observed in connection with a small air compressor which has to supply air at 200 lbs. pressure. This is a two-stage machine, and when first put in was ample for the work it had to do. As is usually the way in a plant of this kind, the factory gradually kept adding to the load until the compressor could not supply sufficient air at the requisite pressure.

This difficulty was overcome by introducing the discharge from another compressor working at 75 lbs. per sq. in. to the low pressure side of the two-stage machine thus enabling it to perform the necessary work without any trouble.

In front of the building is a large spray pond, installed at the time the turbo generator was installed, for the purpose of cooling the circulating water for the condenser. This is used for cooling water in connection with process work in the factory, but apart from that, it has a delightfully cooling appearance on these hot summer days. On the lawn in front of the building there are a number of tennis courts laid out, for the benefit of the employees.

The illustrations herewith show the extent of the power plant in some degree, but of course, this is but a mere sketch of what there is to be seen.

The Ames Holden Tire Co. also have a large factory right at the corner of King Street, outside of which is a large sign inviting visitors to look over the plant, and also offering the use of the grounds to park their automobiles in the meantime.

The Twin City

The sister city of Waterloo is connected to Kitchener by street car, and is distant about three miles, in a straight line along King Street. This intervening distance is practically all built up, many beautiful homes being situated along the road. The main office of the Mutual Life Insurance Co. is situated on this road, and is a very beautiful building, standing in spacious grounds. Waterloo itself contains a number of factories, besides the famous Kuntz Brewery, which of course has now but little interest for residents of Ontario. However, it is probable that some of the delegates might like to look over it, and observe the interesting processes, of what may some day be a lost art.

The Meeting Places

The exhibition of power plant machinery will be held at the hall of the Dominion Tire Systems, 119 King [illegible], while the Grand Lodge meetings [illegible] be conducted at Moose Hall, on Foundry Street, a couple of minutes' walk from the exhibition hall. As usual there will be a good number of firms exhibiting their specialities, while the entertaining of the guests and delegates is in the capable hands of the Exhibitors' Entertainment Committee. The following firms have reserved space for exhibits:

Exhibitors

Jas. Morrison Brass Manufacturing Co., Toronto; Babcock & Wilcox, Montreal; Black Donald Graphite Co., Calabogie; Darling Bros., Montreal; Stephens Chemical Co., Toronto; C. B. Turner & Co., Toronto; Empire Brass Manufacturing Co., London; Dart Union Co., Toronto; Power, New York; W. R. Sexton Boiler Setting Co., Toronto; G. E. Cole, Toronto; Canadian Manufacturer, Toronto; A. H. Winter Joyner, Ltd., Toronto; E. Leonard & Son, London; Thompson Gordon, Ltd., Hamilton; H. Mueller Manufacturing Co., Sarnia; Quaker City Rubber Co., Philadelphia; Power House, Toronto; Crane, Ltd., Montreal; Waterous Engine Works, Brantford; Lunkenheimer Co., Cincinnati; Garlock Packing Co., Hamilton, Dearborn Chemical Co., Toronto; Jenkins Bros., Ltd., Montreal; Goldie & McCulloch Co., Galt.

The Exhibitors' Association Officers

The officers of the Exhibitor's Association are as follows:

Officers of Kitchener Lodge

Fred Pflug, president; Chas. Murril, vice-president; Conrad Ott, recording secretary; Charles Emery, financial secretary; Leander Lindsay, conductor; Ed. Klein, doorkeeper.

The Official Programme

Monday, June 26

Emergency meeting of the Grand Lodge officers at 8 p. m.

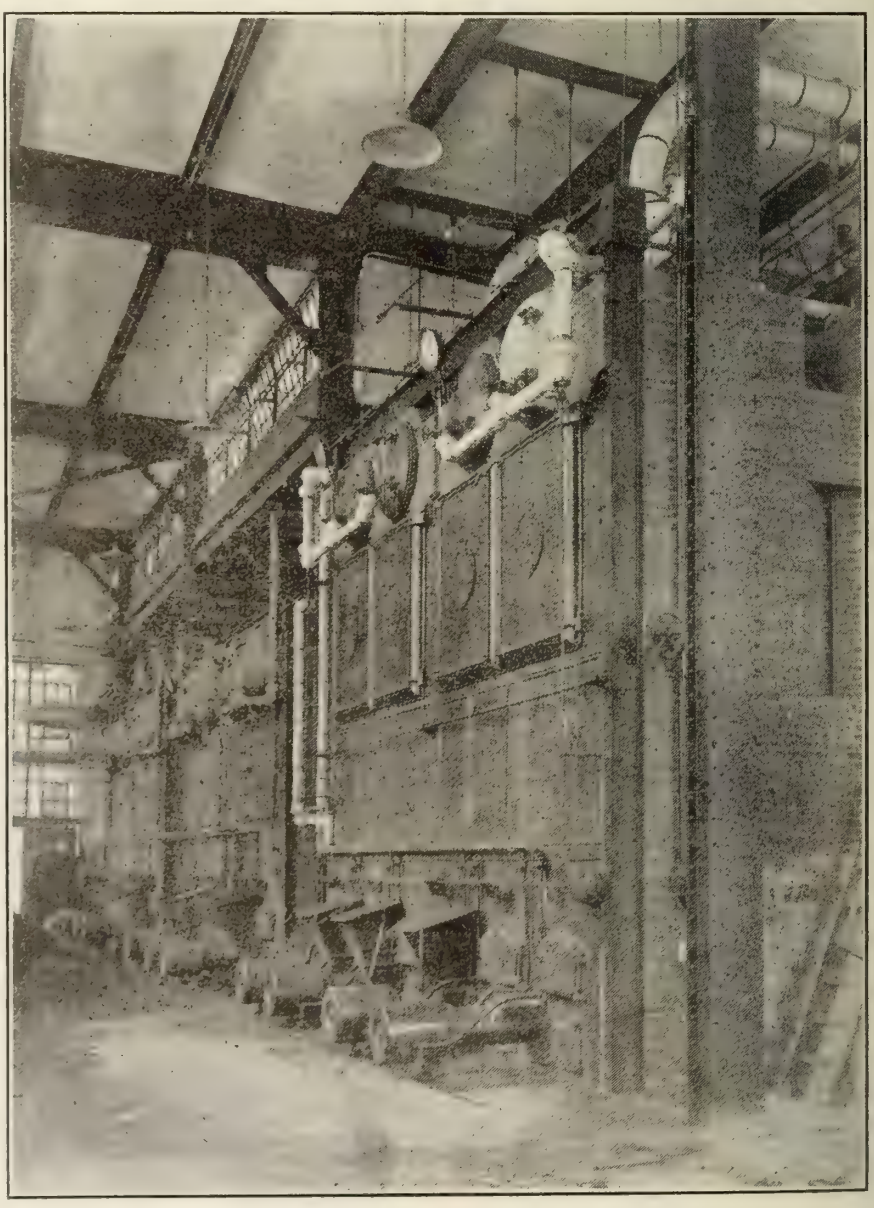
Tuesday, June 27

Opening session Grand Lodge at 9 a. m.

Three minutes' silent respect for the late A. M. Wickens, past president.

Receiving president's and secretary's reports.

Adjourn 9.45.



BOILER ROOM OF DOMINION TIRE SYSTEMS

Four double drum 250 H.P., B. & W. boilers and two double drum Goldie & McCulloch 330 H.P. each.

Official welcome by the Mayor of Kitchener at 10.00.

Official visit to Exhibition Hall by the members of the Grand Lodge.

Grand Lodge session 1.45 p. m.

Grand Lodge session at 8.00 p. m. to consider constitution and by-laws.

Meeting local lodge to which all visitors are invited. Mr. Mess will give an illustrated lecture on flow meters.

Ladies will be entertained by the local lodge.

Wednesday, June 28

Grand Lodge meets at 9.00 a. m.

Sports 2.00 p. m. Races and games, for which valuable prizes will be given.

Entertainment in Exhibition Hall at 8.00 p. m. There will be a musical programme, drawing for prizes and presentations by winners of the Grand Lodge Educational Contest and Membership contest. These prizes have been donated as follows:

Educational: First, Dominion Flow Meter Co.; Second, Moore & Goldie, Montreal; and Third, J. J. Sullivan, president, No. 6, Ottawa.

Membership: First, Fred Harper, Kingston, president, Grand Lodge; Second and Third by L. J. Ellis, secretary of the C. A. S. E.

Thursday, June 29

Grand Lodge meets at 9.00 a. m. for the election of officers and the selection of place for next convention.

Annual meeting Exhibitors' Association will be held at 10.00.

Installation of Grand Lodge officers at 2.00.

A special meeting of the newly elected officers of the Grand Lodge for the appointment of committees.

God Save The King

Wednesday Night

Chairman ..... E. F. Hetherington.
Recitation .... Dorothy Ott
President's Ochestra .....Pres. Pflug's Quartette.
Marimbaphone Duet .....Ott Bros.
Piano Solo .... Anita Stauffer
Solo .... Bob Jones
A Laugh With Jack Armour.
Solo .... E. F. Hetherington

Drawing—10 p. m. Wed. Evening

Engineers:—
1—Fountain pen.
3—Pipe
9—Ratchet screw driver.
15—Hat brush.
21—Mystery box.
Ladies:—
4—Silver fruit ladle.
8—Silver sugar shell.
12—French ivory hand mirror.
16—Mystery box.

Sports

1. One hundred yard dash—Engineers and Exhibitors.
2. Balloon race—Engineers' wives only.
3. One foot hop race—Engineers and Exhibitors.
4. Candle race.
5. Backward running race—Engineers.
6. Ladies' clothes-pin race.
7. Men's smoking race—Engineers only.
8. Potato race—Engineers' wives only.
9. Wheelbarrow race.
10. Little boy's race.
11. Little girls' race.
12. Soft ball game—Engineers and Exhibitors.

Honorary presidents—F. A. Pflug, Kitchener, and Conrad Ott, Kitchener.

Past president—C. B. Turner, 894 Bathurst street, Toronto.

President—Grant E. Cole, G. W. Cole Limited, 2002 Dundas West, Toronto.

First vice-president—J. Thompson, Dearborn Chemical Co., 2454 Dundas West, Toronto.

Second vice-president—R. H. Lyons, Garlock Packing Co., Ltd., London.

Secretary—Gordon C. Keith, The Canadian Manufacturer, 51 Wellington St. West, Toronto.

Assistant Secretary — Bob Jones, France Packing Co., Tacony, Pa.

Treasurer—Lloyd M. Archibald, Dart Union Co., Ltd., 93 Niagara St., Toronto.

Exhibition Committee—Evan A. Peterson (chairman), Crane Ltd., Montreal.

Entertainment—E. F. Hetherington (chairman), Goldie & McCulloch Co. Ltd., Galt.

Reception — Arthur Betton, James Morrison Brass Mfg. Co. Ltd., Toronto.

Next exhibition will be held at Kitchener, June 27, 28 and 29, 1922.

R. H. LYONS
2nd Vice-President

CONRAD OTT
Honorary President

GRANT E. COLE
President

C. B. TURNER
Past President

J. THOMPSON
1st Vice-President

F. A. PFLUG
Honorary President

G. C. KEITH
Secretary

L. M. ARCHIBALD
Treasurer

E. F. HETHERINGTON
Chairman Entertainment Committee

EVAN A. PETERSON
Chairman Exhibit Committee

A. BETTON
Chairman Reception Committee

BOB JONES
Assistant Secretary

OFFICERS OF EXHIBITORS ASSOCIATION

The annual exhibition of power plant equipment and supplies will be held in Kitchener, June 27, 28 and 29, 1922.

Performance of a 60,000 Kilo Watt Station

The Colfax Station, Duquesne Light Co., Cheswick, Pa., Has Been an Interesting Example of Steam Central Power Plant Practice Since its Erection—This Article Deals With Operation Features

By C. W. E. CLARKE

Read before the American Society of Mechanical Engineers.

IT IS the purpose of this paper to describe in some detail the operation of the boiler plant in the Colfax Station of the Duquesne Light Co., located at Cheswick, Pa. Fig. 1 is a cross-section of the boiler house and part of the turbine room of this plant. The Colfax Station at present contains one three-element-compound Westinghouse turbine of 60,000 kw. capacity and an additional similar machine will be installed this summer. The present plans for this station contemplate an ultimate capacity of 360,000 kw. The boiler plant contains seven boilers, 18 tubes high by 51 wide, each containing 20,867 sq. ft. of heating surface; and four additional boilers 20 tubes high by 51 wide, each containing 22,914 sq. ft. of heating surface, are being installed this summer. The station is designed for base-load operation. Under present conditions it is possible to maintain a load in excess of 50,000 kw. for most of the day. For the night periods, from about midnight until seven or eight in the morning, the load may fall as low as 30,000 kw.

The boiler room was designed with a view to securing the highest ultimate efficiency in point of fuel, labor and fixed charges. It will be noted that the labor per horsepower is very small. The area covered by the boiler house per boiler horsepower is only 1.37 sq. ft.

Fuel and Fuel Handling

Coal is brought to the station on a standard-gauge railway in 50-ton hopper-bottom cars from the Harwick Mine, owned by the Duquesne Light Company and located about a mile and a half from the power station. A space about 1,000 by 400ft. just north of the power station is provided for coal storage and is large enough for the storing of about 150,000 tons of coal. A rope-operated gantry bridge is now being erected for handling coal into and out of this storage.

At the plant, coal is dumped into receiving hoppers under the tracks. Crushers are located below the hoppers and the crushed coal is raised by two pivoted bucket elevators to distributing belt conveyors over the bunkers. As the coal goes to the crushers, water is added to help keep down the dust, and as an aid to combustion.

A representative sample of each day's coal is secured by taking individual samples of about 75 lb. from each carload as the cars are dumped. These are placed in airtight cans and so kept until they are to be used. The whole day's samples are then run through an automatic crushing and sampling machine which extracts a 3 to 4 per cent. sample, amounting at the present time to about 40 lb. This 40-lb. sample is quartered on a clean floor and two 3-lb. samples are taken out and put in sealed containers. One of these is sent to the laboratory for analysis and the other is held at the plant until satisfactory analysis of the laboratory sample has been completed.

To secure samples of the coal as fired, a sample of about 1,000 lbs. is also taken from the stoker hoppers at 7 a. m. daily. This sample is treated in the manner described above. Table 1 shows the average of a number of approximate analyses of the fuel and Table 2 a representative ultimate analysis.

The coal bunker is of reinforced concrete and has a capacity of about 240 tons per boiler. Coal is not permitted to remain in the bunker longer than about three days, which practically eliminates any possibility of spontaneous combustion in the bunkers. Distribution of the fuel to the individual stoker hoppers is by means of two weighing lorries each having a capacity of 10 tons. A number of openings in the bottom of the bunker are provided with short cast-iron spouts equipped wiith chain-operated gates and

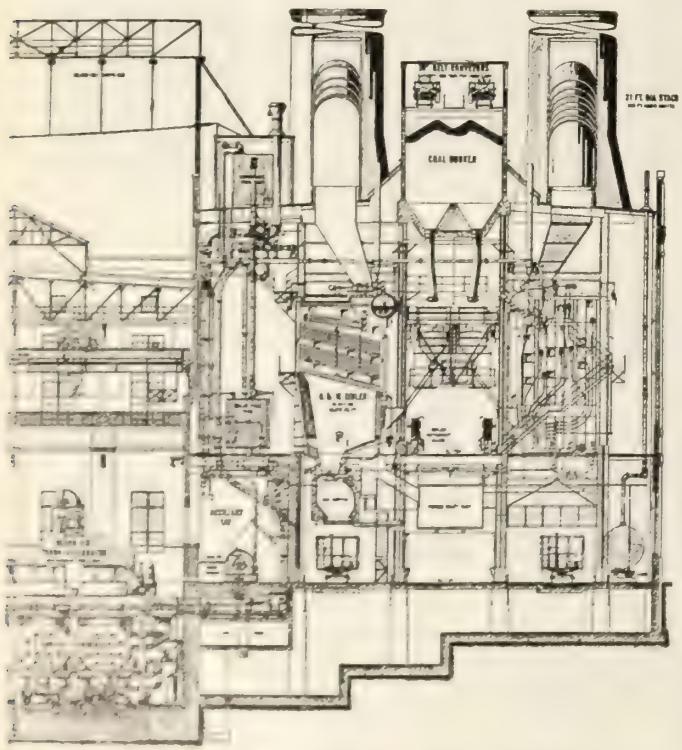


Fig. 1.—Cross section of boiler house and part of turbine room.

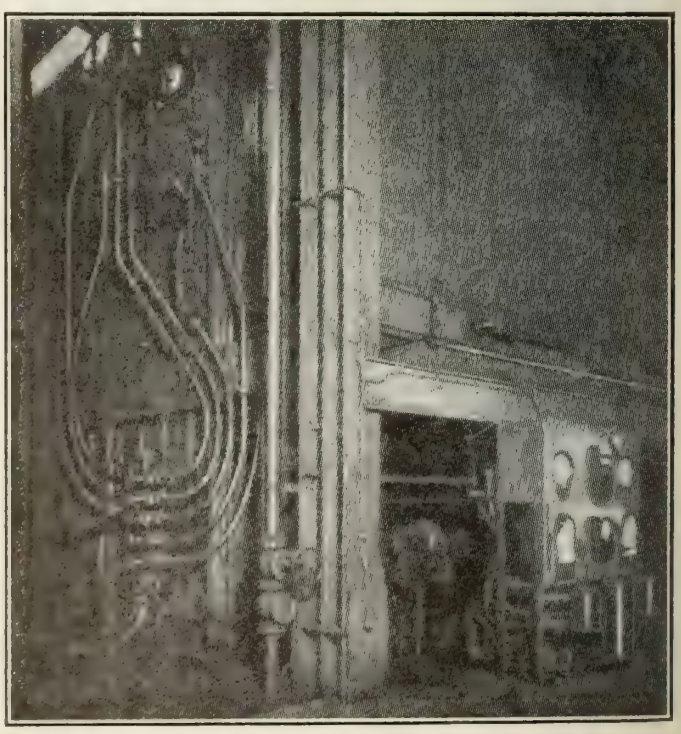


Fig. 2.—Showing control board of boilers.

TABLE I. PROXIMATE COAL ANALYSES

	As Received		Moisture-Free	
	As Unloaded	As Fired	As Unloaded	As Fired
No. of samples	25	30	25	30
Moisture, per cent.	2.9	4.1	..	..
Volatile matter, per cent.	34.5	34.1	35.5	35.6
Fixed carbon, per cent.	53.0	52.5	54.6	54.5
Ash, per cent.	9.6	9.3	9.9	9.6
Total, per cent.	100.0	100.0	100.0	100.0
Sulphur, per cent.	1.0	1.1	1.1	1.2
Calorific value, B.t.u. per lb.	13,351	13,237	13,758	13,895

The difference in moisture between the coal as unloaded and as fired is due to the addition of water at the crushers mentioned above.

TABLE 2 REPRESENTATIVE ULTIMATE ANALYSIS OF FUEL

	As Received	Dry Coal	Moisture-and Ash-Free
Ash, per cent	8.88	9.30	....
Sulphur, per cent	1.09	1.14	1.26
Carbon, per cent.	72.92	76.40	84.23
Hydrogen, per cent	5.39	5.12	5.64
Nitrogen, per cent	1.49	1.56	1.72
Oxygen, per cent	10.23	6.48	7.15
Total, per cent	100.00	100.00	100.00
B.t.u. per lb. by calorimeter	13,202	13,832	15,251
B.t.u. per lb. by analysis	13 199	13,828	15,246.

permit coal to be taken from any part of the bunker.

Stokers and Clinker Grinders

Each stoker is provided with an extension hopper, the capacity of the grate and hopper together being about 25,000 lbs. The stokers are of the Westinghouse underfeed type and have 17 retorts of 20 tuyeres each. The projected grate area of each stoker is approximately 403 sq. ft.

Each stoker is driven by a 15 h. p. variable-speed direct-current motor, equipped with both armature and field control. Current for these motors and for the clinker-grinder motors is supplied by two 2,200 kw. 440 volt a.c. to 125 volt d. c. motor-generator sets located in the auxiliary bay of the turbine room.

The stoker operator is guided entirely by observation of the fires and of the wind-box pressure. The forced-draft-fan speed and consequent wind-box pressure are automatically controlled by variations of the steam pressure in the main header. Wind-box pressure is for this reason somewhat of an indication of load condition. The pressure over the fire is maintained at from 0 to minus 0.1 in. of water by means of balanced-draft damper controllers.

In this type of stoker the upper and lower rams are linked together, but the movement of the lower rams is made much less than that of the upper through lost motion in the linkage. In case the fire piles up on the lower end of the grate this lost motion may be taken out by means of U-links which are left on until the fire is in proper condition. The stoker drive is capable of very close speed regulation and with ordinary care and the occasional use of the U-links, an even fuel bed suitable to the load may be maintained.

Each boiler is provided with an individual instrument and control board shown at the right in Fig. 2. At the top are two pressure gauges connected to either end of the boiler drum. Between them is a three-in-one draft gauge which indicates the pressure in the wind box, over the fire, and in the boiler uptake. Below the draft gauge is a combined CO_2 and furnace-pressure recorder. Each of the two boiler-feed lines is provided with a Simplex venturi meter, the recorders for which are at the bottom of the two side panels. Each of these meters has a capacity sufficient to feed the boiler at over 250 per cent. of rating. The stoker and clinker-grinder motor controllers are bolted to the frame below the board, with the stoker-motor controller in the centre and the clinker-grinder controllers at either side. This places practically the entire control for each boiler at one point so that but one stoker operator is required for 4,175 nominal boiler horsepower, which is over 9,000 developed boiler horsepower at 220 per cent. rating, the normal daytime condition. No centralized control is provided as such a system is of doubtful advantage. The management of stokers, aside from that which can be made automatic, must be almost entirely through visual observation of the fuel bed. There are few factors of stoker control that can be centralized in such a way as to either save labor or fuel. Fig. 2 shows the general arrangement of the boiler, gauge board, etc.

When this installation was first put in operation some difficulty was encountered with clinkering. After considerable experimenting it was definitely determined that this was due in part to periods when there was pressure over the fires and in part to improper water distribution in the clinker pits. Particular care is now taken to maintan a furnace pressure below atmosphere at all times, and the water distribution has been improved as described below with the result that clinker trouble has been practically eliminated.

Some trouble was at first experienced

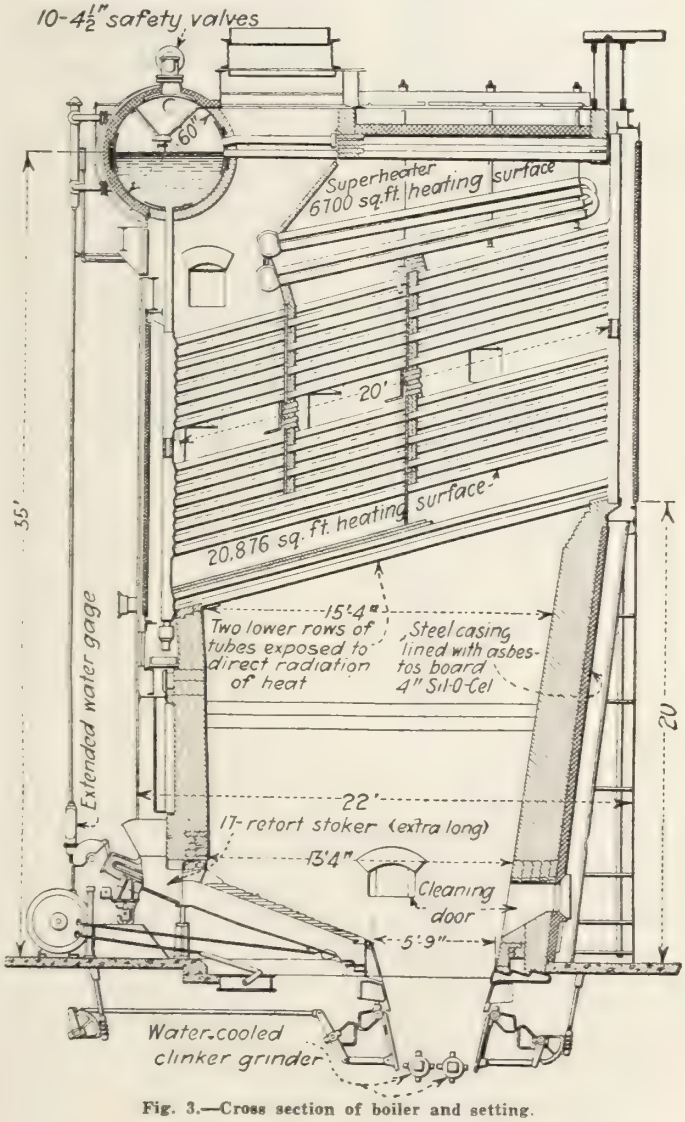


Fig. 3.—Cross section of boiler and setting.

due to burning out of the lower front-feed wedges. This trouble has been largely eliminated by allowing air to blow through from the wind box, thus keeping the wedges cool. To facilitate replacement, the air-box tops and grinder-pit aprons have been made sectional instead of as in the original design.

The stokers are provided with double-roll clinker grinders, divided in the centre, with the rolls turning toward each other. The two halves are driven by separate motors, separately regulated, giving individual control over the two halves of the grinder. The rolls are driven through reciprocating pawls and ratchets which may be disengaged on either roll. It has not been found desirable to operate the rolls continuously. Under normal operating conditions the rear rolls are operated rarely, the front rolls being run for periods of from two to five minutes in every twenty minutes, which means from six to eight revolutions in one hour. Grinder operation is governed entirely by observation of the ash pit. The top of the ash bed is kept above the top of the rear wall air boxes.

To prevent the formation of clinker masses in the ash pit and to cool the clinker rolls, water is introduced above the rolls. Upper-grate box tops having a down-turned projecting lip are installed, under which lip is placed a horizontal spray pipe perforated with quarter-inch holes six inches apart. This pipe introduces the water high up in the ashpit and quite effectually prevents the formation of hard clinker masses. The introduction of water high up in the ashpit tends to quench the ash before combustion is as complete as could be desired, thus increasing the amount of combustible in the ash. At the present time this seems to the lesser of two evils. The sprinkling system requires about fifty gallons per minute for each boiler.

Ash Handling and Sampling

The clinker grinders discharge into firebrick-lined reinforced concrete ash hoppers with an approximate capacity of 60 cu. yd. These hoppers will hold the refuse of from one and a half to two days' normal operation. It is the regular practice, however, to remove the refuse from all working boilers twice a day.

A sample of ash from each boiler is taken every other day. A gross quantity of about 400 lb. is taken from the total 24-hr. dump from each boiler, the sample being taken from six different points in the pile, at a depth of about three feet below the surface of the pile. The whole sample is then hand-crushed and quartered until about three pounds remain, which is sealed in a container and sent to the laboratory to be analyzed for combustible. The method of analysis is in accordance with the specifications of the American Society for Testing Materials.

Boilers

There are at present seven boilers of the Babcock & Wilcox cross-drum type, 18 tubes high by 51 wide, with 20,876 sq. ft. of heating surface and with the so-called "Alert" baffling. There are 918 tubes in each boiler proper and 102 circulating tubes connecting the uptake headers with the drum, making 1,020 tubes in all. Fig. 3 is a cross-section of the boiler and setting. It will be noted that the combustion space is large. The present settings contain 0.345 cu. ft. of combustion space per square foot of heating surface and those to be installed this summer will be the same.

Each boiler has two water columns with high- and low-water alarm whistles. When one of these alarms sounds the operator examines the feed regulators for possible sticking, and if necessary cuts it out and uses hand control until repairs can be made. If the regulator is found to be all right he checks up the feed pressure and if necessary starts another pump or puts on the auxiliary feed.

Furnace temperatures vary from 2,500 to 2,800 deg. fahr.; at the top of the first pass this approximates 1,000 deg. fahr., between the second and third passes it is 530 deg. fahr., and the exit gas temperature varies from 450 to 480, usually being about 470 deg. fahr. Fig. 4 is a chart showing the temperature range and gas velocities through the boiler. Typical temperature and CO_2 traverses are given in tabular form in the complete paper.

Slagging on the boiler tubes is slight and has never been sufficient to cause trouble. The use of distilled make-up water eliminates trouble from scale and consequent tube renewals. The total commercial operation of the seven boilers now installed has been approximately 39,922 boiler-hours up to February 1, an average of 5,703 hr. per boiler and but two tubes have been replaced.

Each boiler is equipped with eighteen soot-blower elements, nine on each boiler. These soot blowers are operated three times a day with the dampers opened wide.

In the past boilers have been taken off for cleaning and repairs after 30 to 45 days of service, but it is expected that in the future service periods will be from 90 to 100 days. This increase is due to some slight modification of the settings and increased knowledge of the performance of the equipment. The work of inspection and repair ordinarily takes from 10 to 14 days. Full efficiency is not reached until from four to seven days after the boiler is put on the line.

The settings are of firebrick throughout, the walls being 18 in. thick. Sil-O-Cel and asbestos millboard fill the 4¼ in. space between the firebrick and the steel casing. Deterioration of the setting is very slight.

The formation of clinker on the furnace walls is prevented by air cooling, Bernitz and Drake blocks being used. These blocks did not altogether prevent clinkering on the side walls and side-wall tuyeres have been installed, which have practically eliminated it.

The superheaters are located over the tube tanks between the first and second pass. Considerable trouble has been experienced because of insufficient superheat. The normal superheat should be

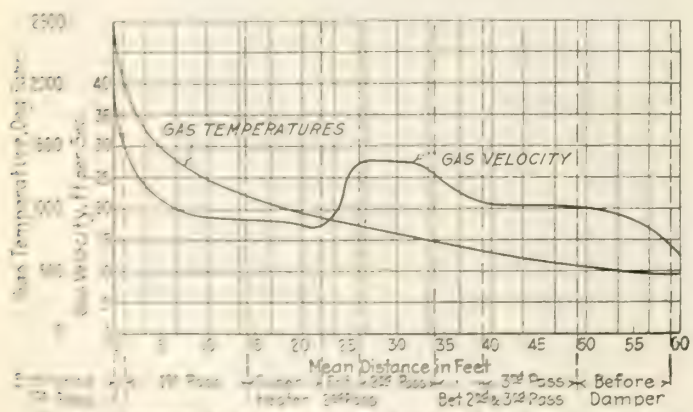


Fig. 4.—Variation of temperature and velocity of flue gas throughout the boiler.

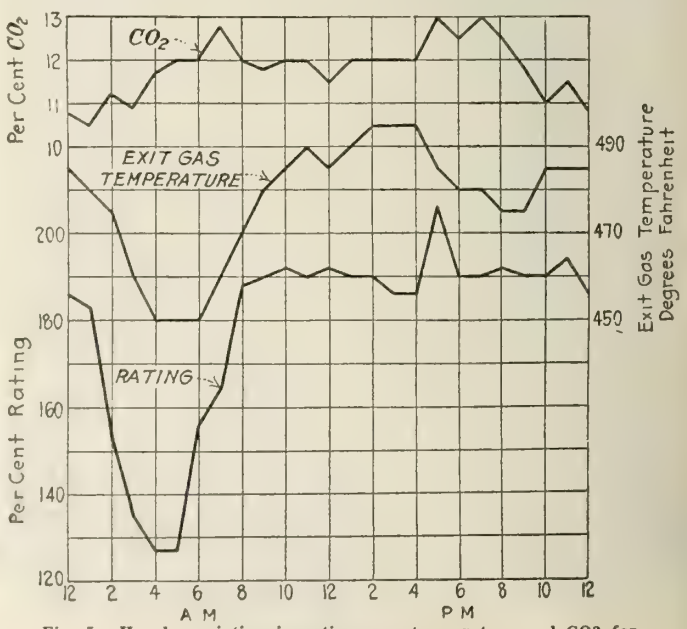


Fig. 5.—Hourly variation in rating, gas temperature and CO2 for typical 24-hour day.

TABLE 3 OBSERVATION OF DISSOLVED OXYGEN IN BOILER FEEDWATER, PARTS PER 1000 BY VOLUME

Head Tank			Boiler-Feed Tank		
Temp., Deg. Fahr.	Actual Dissolved Oxygen	Theoretical Dissolved Oxygen	Temp., Deg. Fahr.	Actual Dissolved	Theoretical Dissolved Oxygen
100	(6) 1.93	4.7	(1) 185	1.21	1.55
101	(10) 2.10	4.65	(2) 186	1.2	1.50
102	(4) 2.15	4.6	(1) 187	1.34	1.45
103	(2) 2.05	4.55	(1) 188	1.11	1.40
104	(5) 2.43	4.5	(1) 189	0.81	1.35
105	No data	4.45	(3) 190	0.88	1.30
106	(3) 1.94	4.4	(2) 191	0.895	1.25
107	(1) 1.99	4.35	(1) 192	1.08	1.20
Mean 102	(32) 2.11	4.6	(0) 193		1.15
			(5) 194	0.75	1.00
			(8) 195	0.65	1.06
			(3) 196	0.70	0.95
			(0) 197		0.90
			(3) 198	0.506	0.85
			(0) 199		0.80
			(2) 200	0.43	0.75
			(0) 201		0.70
			(0) 202		0.60
			(0) 203		0.55
			(1) 204	0.21	0.50
			Mean (193)	(34) 0.766	1.15

TABLE 4 OPERATING FORCE FOR THREE EIGHT-HOUR SHIFTS

Title	No. required per shift 1 unit	2 units	Duties
Boiler engineer[1]	1	1	Responsible for the proper operation and maintenance of all boiler-room apparatus and coal and ash-handling systems.
Boiler operator	1	1	In general charge of boiler operation during his shift. Reports to boiler engineer.
Stoker operator	3	6	Each operates two boilers, including stokers, clinker grinders, dampers, etc.
Soot-blower operator	1	1	Operates soot blowers on each boiler once during the shift.
Larry operator	1	1	Weighs and distributes coal to stoker hoppers, keeping all active boilers supplied. In order to provide a consistent record for daily heat balance, hoppers on all active boilers are filled full between 11.30 and midnight.

[1]Day shift only.

TABLE 5 COAL AND ASH-HANDLING FORCE, ONE TEN-HOUR SHIFT ONLY

Title	No. required 1 unit	2 units	Duties
Coal Handling			
Coal foreman	1	1	In charge of coal handling to bunker.
Coal-conveyer operators	2	2	Operate crushers and conveyer system.
Coal laborers	2	2	Dump coal cars.
Ash Handling			
Crane operator	1	1	Operates locomotive crane in assisting to distribute ash; part time only.
Locomotive operator	1	1	Operates dinky locomotive in shunting coal cars; part time only.
Laborers	2	3	Load ashes to cars.
Miscellaneous			
Coal and ash sampler	1	1	Takes and mixes samples, etc.
Boiler Maintenance			
Boiler-repair man	2	3	Repair leaks, clean inside of tubes, etc.
Boiler-repair-man helper	1	2	
Stoker-repair man	2	2	Repair and overhaul stokers.
Stoker-repair-man helper	2	2	
Bricklayer	1	1	Repair brickwork.
Bricklayer helper	1	2	
Furnace cleaners	2	2	Clean slag from tubes, etc.
Soot-Blower Maintenance			
Pipe-fitter	1	1	Repair soot blowers.
Pipe-fitter helper	1	1	

TABLE 6 SUMMARY OF BOILER DATA—DECEMBER, 1921—COLFAX POWER STATION

Boiler No.	Lb. Water Evaporated	Lb. Coal Consumed	Hours Active	Effici'y per cent.	Rating per cent.	Exit Gas Temp., deg. fahr.	CO^2 per cent.	Combust in refuse per cent.
1	60,020,000	6,638,060	559	76.6	172	489	9.9	26.67
2	55,291,000	6,089,230	480	76.9	185	482	12.0	26.89
3	75,435,000	8,319,030	696	76.7	174	460	10.3	28.60
4	75,542,000	8,324,290	691	76.8	175	481	11.9	25.71
7	32,242,000	3,519,710	285	77.5	183	——	11.5	29.55
6	73,474,000	8,138,360	688	76.5	171	479	11.7	26.88
8	70,546,000	7,761,900	640	77.0	171	481	11.0	27.18
Total	442,550,000	48,790,580	4038	76.8	176	478	11.2	26.99

Average superheat, 132 deg. fahr.
Average feed temperature, 193 deg. fahr.
Average B.t.u. in coal, 13,283 per lb.

180 deg., but 145 deg. has seldom been exceeded. The boilers to be installed this summer will have the superheaters located above the sixth row of tubes, and with this arrangement no trouble from deficient superheat is anticipated.

There is one forced-draft fan for every four boilers. The fans are of the radial-flow type, and have a capacity of 250,000 cu. ft. of free air per minute at a maximum static pressure of 6 in. of water. The fans are driven through reduction gears by 420-h.p. turbines. Each fan engine is provided with a speed controller actuated by variations of steam pressure in the main header. Ordinarily no control of the stoker air other than that provided by the automatic, forced-draft-fan speed control is used, although individual wind-box dampers are provided that may be used in case of emergency. There is one main forced-draft duct, 9 ft. 6 in. by 15 ft., running beneath the firing-aisle floor, from which all stokers are supplied. This duct is provided with sectionalzing dampers located midway between the fan inlets. At each boiler a branch duct runs from the main duct to the stoker wind boxes. The duct system is of 3/16 in. sheet steel made practically airtight without welding.

The generator-cooling-air discharge is carried to the main air-supply duct from which the fans take part of their supply. In addition to this, large openings are provided at the tops of the fan chambers through which air may be drawn from the top of the auxiliary bay. In winter the openings between the fan chambers and the boiler-room basement are closed. This is done to prevent freezing of piping due to drawing large quantities of air from outdoors through the boiler-room basement.

Fig. 5 shows the hourly variation in boiler-room operation over a typical 24-hr. period. Fig. 6 shows the average efficiency, rating and gas temperature for all boilers for the period from July 1921 to February, 1922. This clearly shows the steady increase in efficiency as conditions were improved and as the operating force became more familiar with the equipment. The low point at the beginning of December was due to a period during which there was considerable trouble with clinker.

Piping System

The piping system for boiler feeding consists of a main and auxiliary header. The main header runs below the firing-aisle floor and between it and the forced-draft duct. A feed line is carried up each side of the boiler (these boilers are provided with feed connections at both ends of the drums) and is controlled by globe valves at the boiler-room floor level. Automatic boiler-feed regulators are provided on the feed lines at the boiler drums, part being Stets and part Copes regulators. The auxiliary header runs over and at the rear of the boilers. The auxiliary feed line on one side of each boiler is provided with a by-pass through the automatic

TABLE 7 SIX MONTHS' SUMMARY OF BOILER DATA—COLFAX POWER STATION AUGUST, 1921, TO JANUARY, 1922, INCLUSIVE.

	August	September	October	November	December	January	Average
Total water evaporated, lb.	272,779,000	265,373,000	292,355,000	248,858,000	442,550,000	313,703,500	305,936,417
Total coal consumed, lb.	30,085,600	28,023,100	31,690,300	27,109,300	48,790,600	35,911,530	33,601,738
Total active service, hours	2,782	2,493	2,474	2,361	4,038	2,894	2,840
Average feed temp., deg. fahr.	208	210	203	204	193	204	204
Average superheat, deg. fahr.	124	120	127	127	132	136	128
Average B.t.u. in coal per lb.	13,093	13,180	13,159	13,198	13,283	13,177	13,182
Average efficiency, per cent.	76.4	78.9	78.0	77.2	76.8	77.6	77.5
Average rating, per cent.	154	167	187	167	176	168	170
Average exit gas temp., deg. fahr.	466	460	465	467	478	471	468
Average CO^2, per cent.	9.2	9.3	9.6	10.3	11.2	11.1	10.1

controller, that on the other side being provided with hand control only. The boiler feed system in general is described below.

The piping system was installed in accordance with the general piping specification given in the complete paper.

Feedwater System

The feedwater cycle is shown diagrammatically in Fig. 7. All water in the system is distilled. Make-up water is provided by two evaporators of the double-effect, dry-tube type. Water from the evaporators is pumped directly to the head tanks, above the barometric condensers, which serve as feedwater heaters. The average make-up required is about 19 per cent of the total amount flowing in the system. The tail pipe of the barometric condenser is sealed in the boiler-feed tank from which the feed pumps take their action. Two V-notch meters are provided in this tank; one measures the water going to the feed pump and the other the overflow. All overflow from the system is piped to the boiler-feed tank so that it is recorded by this meter. Overflow from the boiler-feed tank flows to the main storage tank mentioned below. There is some variation between the water quantities recorded by the venturi and V-notch meters, but it is the venturimeter readings which have been used as a basis for all results given in this paper.

There are three 4-stage 1,500-g.p.m. turbine-driven centrifugal boiler-feed pumps, regulated to maintain a pressure in the feed system of 350 lb. per sq. in. One pump is sufficient to supply the total feedwater for a load of about 60,000 kw.

Condensate from the main unit goes first to a surface heater where its temperature is raised about 4.5 deg. fahr. by the transformer and turbine-oil cooling water. It then goes to the evaporator condenser serving there as a circulating medium, and its temperature is increased about 32 deg. fahr. From the evaporator condenser it goes to the head tank and then through the barometric condenser. The exhaust from the house turbine and that part of the exhaust from the auxiliaries which is not used in the evaporators is here condensed, bringing the temperature of the mixture to about 205 deg. fahr.

The storage tank employed has a capacity of 200,000 gal. and serves to take up fluctuations in the demand for feedwater and to provide a reserve supply for emergencies.

The evaporators have in general given satisfactory service. They are so connected that either river or deep-well water may be used. The river water, although very dirty, was found to contain less scale-forming salts than that from the wells, and is therefore generally used. The effects are reversed every four hours, thus minimizing scale formation. The terminal efficiency of the evaporators is practically 100 per cent., and with the modifications now being made it is thought they will give no trouble.

Water qualities throughout the cycle are closely watched. a multiple-point, indicating conductivity meter with cells

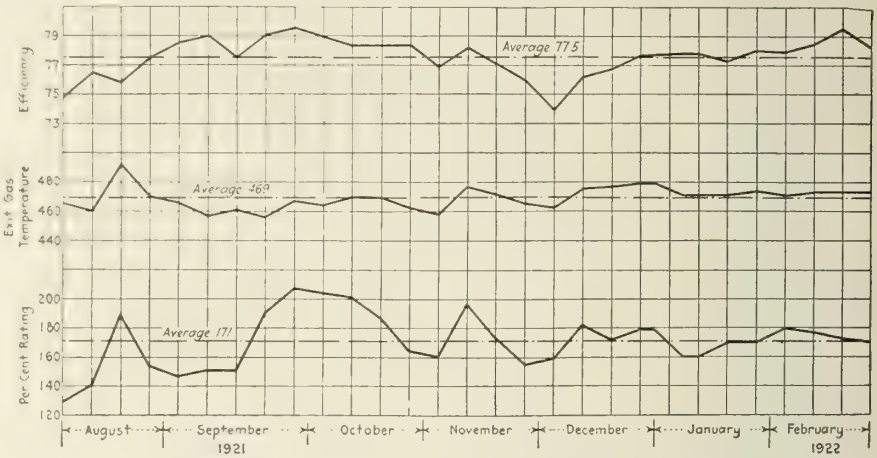


Fig. 6.—Average weekly boiler performance for all boilers. Note:—the points on this curve are the weighted averages of the average weekly efficiencies for the individual boilers, hence the variations at some points.

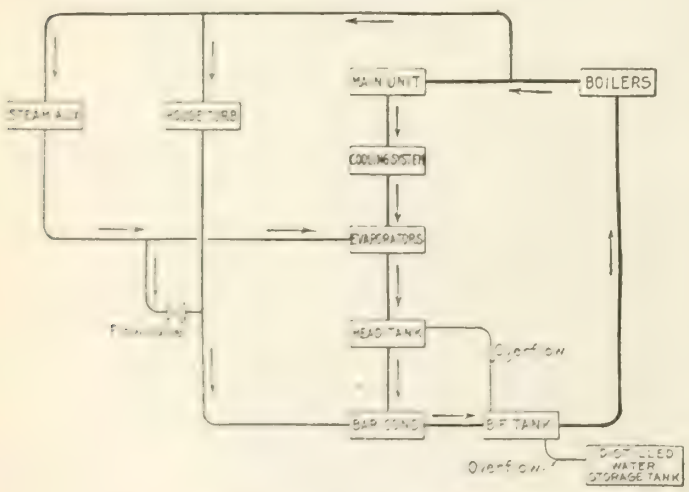


Fig. 7.—Diagram of steam and feed water cycle.

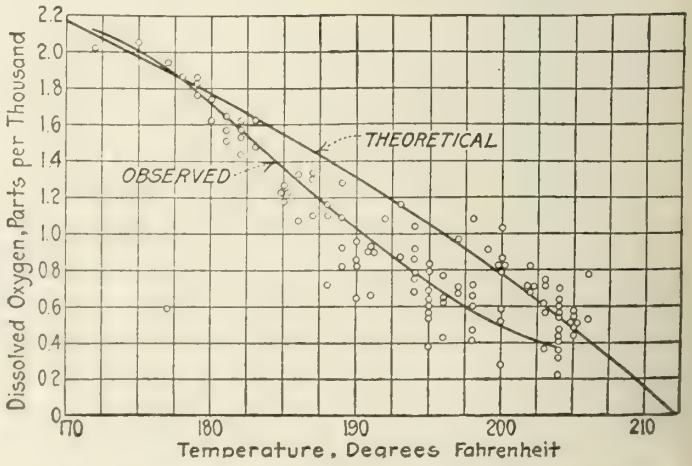


Fig. 8.—Comparison of actual dissolved oxygen in Colfax boiler feedwater with theoretical solubility at varying temperatures.

TABLE 8 TYPICAL HEAT BALANCE DATA—COLFAX STATION

	October	November	December	January
Coal as fired, B.t.u., per lb.	13,159	13,198	13,283	13,177
Ash, as fired, per cent.	9.28	9.37	9.14	9.05
Moisture, as fired, per cent.	4.45	4.12	3.91	4.49
Inlet air temp. deg. fahr.	70	70	70	70
Exit gas temp. deg. fahr.	465	467	478	471
Carbon as fired, per cent.	72.29	72.49	72.86	72.45
Hydrogen as fired, per cent.	4.92	4.93	4.96	4.93
CO^2, per cent.	9.5	10.3	11.2	11.1
Combustible in refuse, per cent.	26.36	29.10	26.99	26.76

	B.t.u.	p.c.	B.t.u.	p.c.	B.t.u.	p.c.	B.t.u.	p.c.
Heat absorbed by boilers	10,264	78.00	10,189	77.20	10,202	76.8	10,225	77.60
Moisture loss	55	0.42	51	0.38	48	0.36	56	0.42
Hydrogen loss	545	4.14	547	4.14	522	4.16	548	4.15
Stack loss	1,713	13.02	1,585	12.01	1,522	11.46	1,502	11.40
Ashpit loss	482	3.66	558	4.23	490	3.69	479	3.64
Heat accounted for	13,059	99.24	12,930	97.96	12,814	96.47	12,810	97.21
Heat unaccounted for	100	0.76	268	2.04	469	3.53	367	2.97
Total	13,159	100.00	13,198	100.00	13,283	100.00	13,177	100.00

located at various points is used to observe the water purity continuously. This instrument immediately indicates leakage of circulating water into the condenser and permits a close check in the quality of the distillate from the evaporator. No condenser leakage has as yet been detected, but much useful information on the performance of the evaporators has been obtained.

It has been found that dissolved oxygen in the feedwater tends to pit the boiler drums. It has also been determined that this pitting takes place during banked periods, there being practically none when the boiler is active. In order to decrease the quantity of dissolved oxygen to the lowest possible point, all parts of the feed cycle are effectually sealed against air. The feed temperature is maintained at 205 deg. or higher to drive out the entrained air. Further experiments are being carried on to determine whether a lower feed temperature with a higher vacuum in the barometric condenser will improve this condition.

Figure 8 shows the relation between temperature and oxygen content as observed at Colfax. Table 3 gives the results of observations of dissolved oxygen in the boiler feedwater taken from the condensate-head tank and the boiler-feed tank.

Tables 4 and 5 show the personnel of the boiler-room organization with one unit as at present, and as it will be when a second unit is installed.

Table 6 is a summary of boiler-room operations for the month of December, and table 7 a recapitulation for the six months, August to January, inclusive.

The heat balance for the station is worked out daily. Table 8 shows the averages of the heat balance figures for the months of October to January, inclusive.

Conclusions

In considering the results given in the paper the following points should be borne in mind:

(a) The operating results given are from the records of the operating department of the Duquesne Light Company.

(b) The plant is not equipped with heat-reclamation equipment such as economizers or air preheaters.

(c) The efficiencies given are not test results but have been made with the regular operating force and can be maintained year after year. The results are good but do not represent the best performance possible with the equipment. Some further improvement is expected as the operating force becomes more familiar with the equipment.

(d) The amount of combustible in the ash is high, but as explained above, the necessity for early quenching of the ash to prevent clinker makes improvement in this respect doubtful. In the light of over-all efficiency the slight excess in combustible is a lesser loss than the formation of hard clinker masses would occasion.

BOOK REVIEW

We have received from the publishers, Chapman & Hall, Henrietta Street, London, a book on boiler-testing, written by Mr. David Brownlie, B. Sc., (London), and a member of a number of the professional societies. The first half of the book is devoted to results being obtained at present in Great Britain, and by reason of the very wide range in types of boilers and plants covered, running into the hundreds, the figures are very valuable. Mr. Brownlie has condensed the result of hundreds of tests to an average performance, and it proves beyond doubt what many of us have always felt, that the average performance is extremely poor. Following this Mr. Brownlie criticises the present codes in existence for testing boilers, and not content with mere criticism he suggests new features which may be added to an international code as a result of further investigation.

Mr. Brownlie thinks the code of the A. S.M.E. is far better than the code of the Institution of Civil Engineers in use in England, but he is not satisfied with their revised code in all particulars. He thinks that the time is ripe for an international code, to be drawn up by the British, French, and American engineering societies and scientific societies working together.

This book from the pen of a man who has wide experience in the actual testing, and tabulation of results of so many different tests, will give food for reflection to those interested in getting at the real performance of boiler plants. The criticisms he makes are of a practical nature and so are the suggestions for changes. Altogether, it is a book of great value to the consulting or testing engineer, and to those in charge of large plants who make daily run tabulations. The book is ten shillings and sixpence in London.

FUELS FOR WATER GAS MANUFACTURE

A series of tests on the use of mixtures of coal and coke in the manufacture of water gas is planned by the Bureau of Mines, to be conducted at plants at Davenport, Iowa; Ottawa, Illinois; and Beloit, Wisconsin. Wilson J. Dunkley, gas engineer, of the Urbana, Ill., station, will conduct the tests.

PREPARATION OF COAL STUDIED

At the Central District experiment station of the Bureau of Mines, Urbana, Illinois, in the course of a general study of the preparation of coal, Thomas Fraser, assistant mining engineer, has completed experiments on the determination of the minimum sliding angles of different coals on steel. A study of the general subject of coal screening is being made at this station.

EQUIPMENT FOR BURNING LIGNITE CHAR.

In the course of the experiments being conducted by the Bureau of Mines at Pittsburgh, Pa., looking toward the development of grates and furnaces to enable lignite char to be used for domestic purposes, a sheet iron grate for use in base burner stoves has been designed which permits lignite char to be burned in such stoves in place of anthracite. The development is of interest in connection with the problem of commercial utilization of the vast lignite deposits of the Northwest.

AN ANNOUNCEMENT

The Taylor Instrument Co. of Rochester, N. Y., have purchased the building at the corner of Church Street and Lombard Street, Toronto, formerly known as the Stevenson Building, but now to be called the "Tycos" building. The Taylor Company are carrying on assembling and repair work in the Toronto factory at the present time, and for the moment they will confine themselves to this work. The extent to which the company will manufacture or assemble the various instruments comprising their well known lines, will depend entirely on the Canadian demand.

Practical Electricity for the Power Plant Engineer

By G. R. ARCHDEACON, A.M.I.E.E.

CHAPTER VI.

OWING TO THE rapidly increasing use of Storage Batteries for such purposes as starting the Auxiliary gasoline driven fire pump in the local water works, fire a arm systems in factories, automatic te ephone systems, in warehouses and departmental stores, it has now become imperative that the engineer should devote a little of his time in acquiring a sound working knowledge of the underlying principles governing the operation and care of storage batteries.

It is a well known fact, that there is nothing employed in the modern Power Plant that is so little understood, and so much abused as the storage battery.

All other pieces of apparatus in the power house quickly resent ill-treatment and soon give audible evidence of such resentment, whereas the storage battery, hidden in a p ain "black box of mystery" or contained in its glass jar, refuses to "squeak" or "groan" or "hammer." Hence it is all too frequently assumed that "all is wel with the child."

Of all the machines in the power house the storage battery is the one that responds in the most generous manner to the proper care and attention, as no other machine can supply the amount of overload as the storage battery. The storage battery is often called upon to supply 200 or even 300 per cent. overload. And never fails to respond if in proper condition.

Before we can approach the underlying principle of the storage battery it is necessary to obtain a grasp of the principles of electrolysis.

Electrolysis

When a D.C. current passes through any non-metallic liquid which has electrical conductivity, chemica action takes place. The fluid is decomposed and split up into its original elements.

For such reasons it is always necessary to add a small percentage of salt, or sulphuric acid to a tank of water through which you desire to send a current of electricity, as frequently arises when it is necessary to erect some form of water resistance.

The higher the percentage of salt or acid added to the water, the lower will be the resistance of the water, with a consequent increase in its conductivity.

In sending a current of electricity through the chosen liqquid the end of the positive wire is inserted into the solution at one side of the tank, and the end of the negative wire is inserted at the other side of the tank. Care must be taken to see that they do not touch together, or it would result in a "short circuit."

We now speak of these two wires as electrodes, or poles, and they are given special names, which must now be learned off by heart. That part which is immersed in the liquid is called anode or cathode according to whether it is connected to the positive pole or the negative pole.

The wire connected to the positive pole of the dynamo, is known as the anode.

The wire connected to the negative pole of the dynamo is known as the cathode.

The current flows from the positive pole of the dynamo to the anode, leaves the anode to pass into the liquid flows through the liquid to the cathode. It then leaves the liquid, travels up the cathode out of the liquid and then back to the dynamo along the negative wire.

The chemical action only takes place at the points just where the current leaves the anode to enter the liquid, and just where the current enters the cathode, as it leaves the liquid.

No chemical action occurs in any other part of the electrolyte.

This restricted area of operations is due to the action of the ions. These ions are the carriers of the electricity through the electrolyte. They are supposed to be groups of atoms, which are charged either positively or negatively and move in a continuous procession through the electrolyte.

Those ions who carry a negative charge, are called anions.

Those ions who carry a positive charge, are called cations.

The negatively charged anions pass in a direction opposite to the current flow, going towards the anode, and there give up, the charge being neutralised by the positive charge of the anode.

The positively charged cations pass in the same direction as the current flow, flowing towards the cathode, and there give up, the charge being neutralised by the negative charge of the cathode.

Put in a concise form an ion is merely an atom or group of atoms charged with a certain quantity of electricity, which it tranfers from one electrode to another.

From this it will be apparent that there is actually no "direction of current flow," as this is absolutely a matter of the ions taking on their respective charges, and transferring these charges between the anode and the cathode.

The usual products of electrolysis of weak solutions of acid and water (remembering water in a pure condition will not conduct the current) are oxygen and hydrogen.

The oxygen appears at the anode, and the hydrogen appears at the cathode.

The quantities of oxygen and hydrogen formed by the passage of a current of D. C. electricity through slightly acidulated water is always in the same proportion, viz.:

Eight times as much of oxygen as of hydrogen by weight.

Twice as much hydrogen as oxygen volume.

These proportions being nature's fixed limits for the proportions of these gases when combined to form water, or what is expressed chemically as H_2O.

Whenever chemical dissociation is produced, energy is required.

The energy necessary being proportional to the amount of heat set free when the compound was formed by the

combination of its constituent molecules.

Conversely, when chemicals in an electrolyte combine to form a new substance, the heat energy of formation may manifest itself as electrical energy instead of heat.

This fact makes possible the electric battery.

Let us now briefly review the laws laid down by Michael Farady (an Englishman) who established the principal laws controlling electro-chemical action.

(1) The amount of substance liberated at an electrode is proportional to the amount of electricity passed through the cell.

(2) The amount of each element deposited by unit quantity of electricity is a definite and constant quantity, which is termed the electro-chemical equivalent of the element so deposited.

(3) If the same quantity of electricity be passed through different electrolytes, the weights of the different substances deposited, will be proportional to their respective electro-chemical equivalents.

These laws can be expressed as follows:

Let Z = Electro-chemical equivalent.

Let Q = No. of coulombs of electricity.

Let c=Amperes flowing in the circuit.

Let t = Time in seconds.

Let W = Weight of substance deposited in grams.

Then W = Z x Q.

Whilst for a steady passage of current of C amperes for t seconds

Q = c x t

W = Z x c x t.

The electro-chemical equivalent of a substance is the ratio of quantity, by weight of the substance which is decomposed by one coulomb of electricity, to the quantity of hydrogen liberated by the passage of one coulomb.

Numerically this is supposed to be equal to the atomic weight of the substance divided by its valency.

Hydrogen being the lightest gas is taken as the standard, both in regard to its atomic weight, and its valency. It is therefore regarded as unity, or equal to one. Therefore its electro-chemical equivalent must be also unity.

The following table gives the electro-chemical equivalents of a few of the principal elements.

Element	Electro-Chemical Equivalent
Aluminum	0.0000936
Copper, (cupric)	0.0003281
Iron, (ferrous)	0.0002902
Lead	0.0010716
Mercury	0.0010374
Nickel	0.0003043
Sodium	0.0002388
Silver	0.0011181
Tin	0.0006116
Zinc	0.0003370
Gold	0.0006791
Hydrogen	0.0000104
Oxygen	0.0000823
Nitrogen	0.0000485

It is interesting to pause here and take note of the electro-chemical equivalent of silver, 0.0011181.

Upon turning back through this series of articles, there will be found on Page 40 of Feb. 20th issue a list of practical Definitions, the first definition being that of the Ampere. Let us therefore repeat this definition.

The Ampere is the unvarying electric current which when passed through a solution of Silver Nitrate of particular strength deposits Silver at the rate of 0.0011181. Gram per Second.

Remembering that one Ampere per Second is equal to one Coulomb it will be apparent upon again carefully reading the definition of the Electro-Chemical Equivalent that this fact is proved beyond question.

If two suitable metal plates are interposed in an electric circuit and are placed a short distance apart in a liquid which is a chemical compound, the current flowing in the circuit will cause the liquid to be split up into its component parts.

If the constituents of the liquid are gases, one gas will be given off at one plate, and another gas will be given off at the opposite plate.

If one of the constituents of the liquid is a metal(as with Copper Sulphate, or Silver Nitrate Solutions) this metal will be deposited on one of the plates. This plate is called the **Cathode**, whilst the other plate is called the **Anode.**

The solution is called the electrolyte, and the process is known as Electrolysis.

Volta (an Italian) discovered in 1790 that if electrodes of two chemically dissimilar conducting materials are immersed in an electrolyte, which can attack one or both of the electrodes, an electromotive force is produced. This naturally results in a flow of current when the external circuit between the electrodes is closed.

Whilst the circuit remains open little chemical decomposition takes place. When the external circuit is closed, a flow of electricity takes place, and the chemical action becomes violent, and the attackable electrode is either gradually eaten away, being dissolved in the electrolyte, or it combines with the electrolyte to form another substance.

Volta found the amount of the electrode destroyed or converted was proportional to the quantity of electricity which was taken from the cell.

Any two chemical dissimilar electrodes which give rise to an electromotive Force when immersed in an electrolyte are called a Voltaic couple.

There are two different classes of Voltaic Couples—

(a) Chemical electrodes which give an electromotive force, until the chemicals are exhausted, and then have to be discarded.

(b) Chemical electrodes which are not exhausted or dissolved, but undergo certain definite chemical change until a limit of such change is reached. After which they can be returned to their original condition by sending a current of electricity through them in the opposite direction.

Any Voltaic Couple which is capable of functioning under the conditions mentioned in—

(a) is known as a primary battery.

(b) is known as a secondary battery or storage battery.

We are now in a position to fully consider the phenomenon of the so called storage battery. Strictly speaking this term storage battery is incorrect, because the battery in queston does not actually "store up" electricity in a similar manner that water can be"stored up" in a tank, and by the simple process of opening a valve take out of "storage" so much water.

The laws of electrolysis control the functioning of the so-called storage battery, and we have shown it is necessary to establish a positive charge upon certain hydrogen ions, and a negative charge on another set of ions, and that it is entirely due to the interchange between these ions that the electric current is caused to flow.

It is therefore obvious that we do not put so many amperes into a battery, and store them there like so much water in a tank. This is a question of energy transformation, rather than storage.

In this instance we have transformed electrical energy, into chemical energy, and if we reflect on this particular transformation we will realise that we have got back to the starting point.

The heat energy of the burning coal is changed into the kinetic energy of the steam engine turning the dynamo, the kinetic energy of the steam engine into the electrical energy of the dynamo, the electrical energy of the dynamo into the chemical energy of the storage battery.

As the heat energy released in the combustion of the coal is due to chemical energy, we once again demonstrate the old truth "you cannot create or destroy matter."

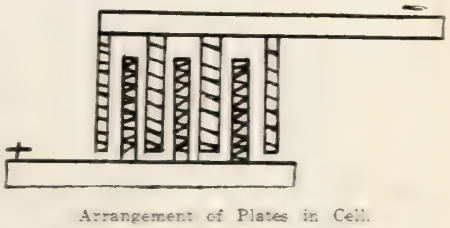
COMPONENT PARTS OF A STORAGE BATTERY

The Lead Acid Storage battery always consists of a set of Positive plates, and a set of Negative plates.

The Positive plates are usually when healthy a dark chocolate colour.

The Negative plates are a fairly light slate gray colour.

Both plates are immersed in a dilute



Arrangement of Plates in Cell.

solution of sulphuric acid and distilled water.

The plates are joined up into Positive and Negative groups.

(Continued on page 34)

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field. Steam. Electricity and Refrigeration.

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Suggested Special Certificates

WE REFERRED in our last issue to a protest made by the Ottawa Lodge of the C.A.S.E. anent the issuing of special certificates. We expressed the view at that time, based on the meagre information at hand, that the engineers were perhaps becoming unduly alarmed. Since then, we have had more complete information on the matter, and we find that the issuing of these so-called special certificates would be in the interest, instead of against the interests, of the stationary engineers of Ontario. To begin with, we are informed that absolutely no action has yet been taken in this matter, it having not yet passed the stage of a suggestion. In order that readers may see just exactly what the suggestion embodies we are reproducing it here in its entirety. It will be seen that the measure is designed to fit the case of those small industries where the use of the boiler is seasonal, and the employment of a regular engineer would be impossible from the commercial standpoint. In these small industries there is usually a man employed in some other part of the business, who on occasion takes charge of the boiler. The special certificate will enable this man to continue to take charge, providing he can satisfy the examiners that he is a responsible man and has sufficient knowledge to operate the boiler safely. What it will not do, is to allow him to go to any other plant and pose as a certificated engineer. The certificate is nothing more or less than a temporary permit, to operate a specified plant for a stated period.

In our opinion, it is a common sense way of getting over a question of considerable difficulty. These jobs are not ones that the engineer who is making stationary engineering his regular profession would want to take, as they probably last only from three to four months during the year. On the other hand, there is nothing to prevent the certificated engineer from taking such a job if he wishes, at the wages such firms can afford to pay.

The issuing of the proposed certificate would enable the employer to utilize the services of the man who has probably been doing that same job for season after season, and still remain within the law. Nobody as far as we can see would be injured by the proposed certificates, and at the same time it would relieve these small industries from what might easily become a heavy burden.

A person who desires to operate a specified stationary steam plant of not over 100 h.p., when used in the operation of steam laundries, creameries, cheese factories, jam factories, greenhouses and other plants of similar nature, where not more than seven persons are employed must hold a fourth-class or third-class certificate from this Board, depending on the size of plant; or a special certificate which, upon examination, may, at the discretion of the Board, be granted. A special certificate shall not entitle the holder thereof to operate in any plant other than that which is specified on the certificate.

A candidate for examination for special certificate shall be required:

(a) To be at least 21 years of age;

(b) To take an affidavit on a form supplied by the Board, showing that he has had at least one year's operating experience, including at least six months' operating experience in the boiler room;

(c) To satisfy the board as to character and ability;

(d) To pay a fee of three dollars at the time application is made for examination. (This fee shall not be returned to the applicant should he fail to pass the examination);

(e) To answer the questions on the examination paper and secure at least sixty per cent. of the marks.

A candidate for examination for special certificate is required to possess:

A knowledge sufficient to operate with safety all boilers, engines, and other apparatus contained in the plant which he desires to operate.

Application for a special certificate or for the annual renewal of same shall not be accepted by the Board unless accompanied by a statement from a qualified boiler inspector in the employ of a boiler insurance company registered in the Department of Insurance, or a qualified boiler inspector in the permanent employ of the Ontario Government, or by an engineer who has obtained his first-class or second-class certificate since January 1st, 1920, to the effect that the boiler or boilers which applicant desires to operate has or have been inspected internally by such an inspector at least once during the year immediately previous.

New Steel Developed

STILL ANOTHER announcement has been made on the "discovery" of a new steel. In this case an actual improvement is said to have been accomplished by Mr. P. R. Kuehnrich of the Cobalt Steel Co., Sheffield. Cobalt magnet steel is the subject, and the improvement is reported to be an excellent one in making magnets for automobile magnetos. By adding 15 per cent. of cobalt in place of tungsten a magneto can be reduced to half its present size without reduction of power. Hence price reduction is forecast. Said Mr. J. F. Kayser, managing director of the company: "In the construction of telephones it is possible in every case to replace tungsten steel magnets of complicated shapes by straight bar magnets of cobalt steel of less than half the size, so that a big economy in material is introduced." Mr. Kayser added that the new metal will make it easy for motor car manufacturers to provide combined lighting and ignition sets. In this enumeration of mechanical blessings somebody has missed the fact that the incorporation of cobalt is not a recent invention in steel making. No harm will occur through waiting until something tangible is offered.

Refrigeration For The Power Plant Engineer

The Absorption Process of Refrigerating—Aqua Ammonia—General Construction and Details of Parts of the Machine, and a Few Words on the Operating Features of the Machine

THE ABSORPTION refrigeration machine, while it works on the same scientific principles as the compression machine, is materially different in its construction and method of operation.

In the absorption machine the only moving part of the machine itself, is a small ammonia pump. In a brine system there are, of course, the brine pumps, but they can hardly be considered as a part of the machine, but rather as auxiliaries.

The heat imparted to the ammonia, instead of being obtained by doing work in compressing the gas, is given direct to the ammonia in a generator, or still, and the gas is, instead of being condensed to liquid ammonia, absorbed in a weak solution of aqua ammonia and converted into a strong solution of aqua ammonia, and returned to the generator. Here it is again distilled, and sent on its cycle again. Briefly, the system may be described thus: Distillation of ammonia gas from aqua ammonia in a generator or distiller. Condensation of the ammonia gas to liquid ammonia in a condenser, as in the compression machine. Liquid ammonia converted into a gas in the evaporation side of the machine, taking up the necessary heat from the objects to be cooled. Absorption of the gas by a weak solution in the absorber, making it into the original strength. Pumping from the absorber to the generator by a pump, whence the cycle is again started.

Aqua Ammonia

Aqua ammonia consists of a solution of ammonia gas in water the amount of gas in the water per cent. being measured by the Beaume scale. This scale is graduated to show the specific gravity of different liquids compared to water at the temperature of 60 degrees. The scale is marked with the necessary corrections for temperature above and below 60 degrees, and in some of the instruments, a thermometer is included. The Beaume hydrometer consists of a tube with a bulb on the bottom, and in this bulb small shot is placed for a weight. It will float in water at a certain height, and in any other liquid at a different height, depending on the specific gravity of the ilquid. The reading on the Beaume scale can be converted into specific gravity in the following way. For liquids lighter than water, 130 plus the Beaume reading, divided into 140 gives the specific gravity and for liquids heavier than water, 145 minus the Beaume reading divided into 145 gives the specific gravity. These calculations are for liquids at 60 degrees F.

The aqua ammonia supplied to absorption machines usually has a specific gravity of 15 degrees Beaume, and this corresponds to a percentage of 30.1, usually known in the trade as 29½ per cent. aqua. The actual specific gravity of this liquid is .8974, and it is shipped in drums containing from twenty to forty gallons. The aqua ammonia is put in the machine by connecting it up to the ammonia pump, and pumping it into the generator. Care must be taken not to leave the drum in a hot engine room, or in the sun, just previous to taking the plug out, as the heat will generate a pressure in the drum. The result will be that when the plug is removed, the ammonia will be blown out of the drum, with unpleasant results to anyone in the immediate neighborhood, and the loss of the ammonia.

The Generator

The generator consists of a steel cylindrical vessel, in which are steam coils, the ends of which are connected to headers on the outside of the generator. The generator must be of sufficient strength to withstand high pressures, and is usually made with an ultimate strength of about 500 lbs. per square inch. The aqua ammonia is placed in the cylinder, submerging the coils, just as the water in the h.r.t. boiler submerges the tubes.

The coils are supplied with steam, either exhaust or live steam reduced in pressure. One of the advantages of the absorption machine is that it can be run on exhaust steam where that is available. When exhaust steam is used the back pressure carried is from five to ten pounds per square inch. The steam when admitted to the coils, gives up its heat to the aqua ammonia in the generator, causing the latter to boil. The gas is thus evaporated from the water, and rises up, leavin the weak solution on the bottom. The pressure of the ammonia gas is of course raised, due to the great increase in volume and the pressure of the generator rises to 130 to 150 lbs. per square inch. The level of the liquor in the generator is maintained by the ammonia pump which is constantly pumping liquor from the absorber to the generator. The generator is also connected to the absorber by a pipe leading from the bottom of the generator to the top of the absorber. The pressure in the generator being higher than that in the absorber, forces a stream of weak liquor over to the absorber all the time. The generator is furnished with a gauge glass so that the height of the liquid can be observed at all times, and the coils kept submerged, so that all the heat can be utilised.

The ammonia gas, distilled from the aqua ammonia in the generator, rises through what is known as the analyser. This

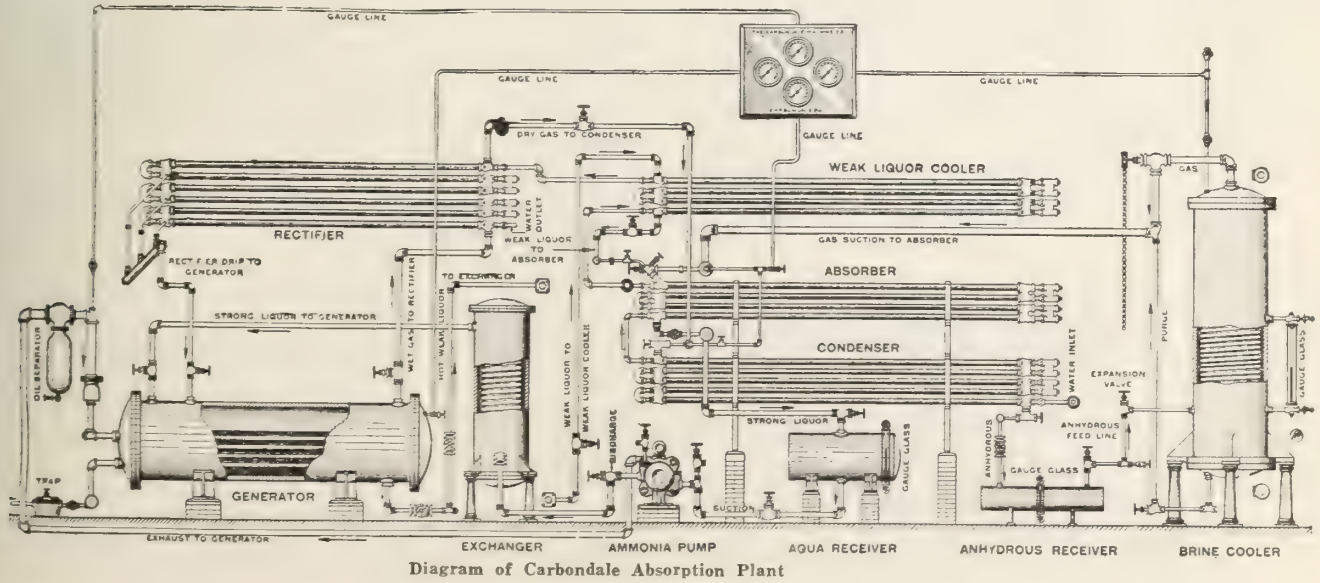


Diagram of Carbondale Absorption Plant

consists of a vertical cylindrical vessel, containing a number of shallow basins, and over these trays are suspended. The liquid returning from the aborber to the generator is introduced at the top of the analyser, and falls downward over the trays and basins, meeting the hot gas rising in its course. The hot gas gives up some of its heat to the strong liquor on its way to the generator, and at the same time any entrained moisture in the gas falls back into the basins and so back to the generator.

The Rectifier

The gas after leaving the analyser passes to the rectifier. This is a set of coils, either of the double pipe or submerged type, having just enough water circulation to condense any watery vapor there may be remaining in the gas, before it passes to the condenser. This rectifier must be kept at a temperature just sufficient to accomplish its purpose without condensing any of the dry gas. The temperature is in the neighborhood of 110 degrees. The function of the rectifier is purely to condense any vapor and leave the ammonia gas absolutely dry. The condensate returns direct to the generator. The gas is all this time on its way to the condenser where it will give up its latent heat to the circulating water, and become ammonia liquid, or rather liquid ammonia. The condenser is of the same type as those described in the previous articles, and may be of the atmospheric, or double pipe design. From the condenser the liquid ammonia is passed through the expansion valve either to the direct expansion coils, or to the brine cooler, which may be of the double pipe, or shell type as previously described. After having been evaporated and taken up the heat from the brine or rooms, as the case may be, the gas is ready to go to the absorber.

The Absorber

The absorber may be of the shell type, atmospheric type, or double pipe type. In the shell type, which may be either horizontal or vertical, the gas coming from the suction side of the machine enters at some distance from the top, directly underneath the spray from which the weak liquor from the bottom of the generator is discharged. The weak liquor, spraying down, absorbs this gas. It is necessary to use cooling water in the absorber, and this is usually done by means of tubes, through which the water after leaving the condenser is passed. The cooler the weak liquor is kept, the greater are its absorbing powers.

The Exchanger

The weak liquor coming from the bottom of the generator to the absorber is at a fairly high temperature, in the neighborhood of 200 degrees. The strong liquor coming from the bottom of the absorber is at a temperature of about 80 degrees. The heat is required in the generator but not in the absorber, so the exchanger is introduced to exchange the heat from the weak liquor to the strong liquor. This is done by means of a double pipe coil, the weak liquor flowing through one pipe, and the strong liquor through the other. These coils are arranged on the counter current system, as described previously in the articles on the compression system. The strong liquor after leaving the exchanger flows through the analyser, taking up more heat from the gas rising from the generator. It will thus be seen that all through this machine the idea is to utilize all the heat possible where it is needed by simple methods. The hot gas from the generator gives up heat to the strong liquor going to the generator, which has to be heated up by steam. The condensing water after taking up the latent heat of the ammonia gas in the condenser, is still at a temperature where it can be used in the rectifier and absorber, thus saving water.

Our illustration shows a complete plant on the absorption system as made by the Carbondale Machine Co., Carbondale, Pa. This machine is constructed entirely on the double pipe

Operation

The system after being tested out in the usual manner for leaks in the various coils, is supplied with the required amount of ammonia liquor. The generator should be filled until there is a depth of four to six inches of liquid over the steam coils, and the absorber should also have a charge of strong ammonia liquor, enough to show about half glass, in the gauge glass placed at the bottom of the absorber. This is necessary as a reservoir, for as soon as the machine is put in operation, and the gas starts going over to the condenser, the pump must be started drawing strong liquor from the absorber to the generator, and the weak liquor will be at the same time passing from the bottom of the generator to the absorber.

The first thing to do in starting an absorption machine is just the same as in a compression system, and that is to turn on the circulating water on the different parts of the system. Next turn on the steam to the generator coils, when the evaporation of the ammonia liquid will commence, and the pressure will rise on the condenser side of the system. This includes the generator, analyser, rectifier and condenser. When the pressure has reached the normal amount, which is dependent on the temperature of the condensing water and is usually from 125 to 160 lbs., the expansion valve can be opened, and the liquid admitted to the cooling coils. The valve which controls the supply of weak liquor from the generator to the absorber should now be adjusted, and the ammonia pump started, and the regulation should be such that the levels of the liquid in the generator and absorber should be kept constant.

In some cases automatic regulators are installed, which control the pump speed. If these are not fitted constant vigilance is required as the levels are constantly tending to change, and the pump must be adjusted contmually.

One of the principal points in operating the absorption machine is having a good supply of water, and the lower the temperature of this the better. If the circulating water is high in temperature, then the condenser pressure is higher, and that means that the steam pressure to be carried will have to be increased somewhat.

The absorption machine is subject to troubles from the introduction of air just as the compression machine is. However, the purging can be accomplished from the absorber, connections being fitted at the bottom and about half way up for this purpose.

The general working of the machine can be gauged by frequent testing of the strength of the liquor coming from the absorber. This should be about 26 degrees for the strong liquor and about 18 degrees for the weak liquor leaving the bottom of the generator. These proportions should remain about the same, that is if one drops the other should also drop. If the two densities approach each other it is an indication that there is a leak probably in the exchanger, so that the strong and weak liquor are being mixed.

The quality of the circulating water will determine how long the machine can run without cleaning coils. If there is much solid matter in the water, it is likely to be precipitated in the cooling coils in the absorber and condenser, and it is highly important that the absorber circulating coils in particular should be kept clean. Any rise in temperature of the ammonia liquor in the absorber reduces its capacity to absorb the gas. This means that the gas cannot pass away from the suction side as rapidly as it should, and the capacity of the machine is reduced.

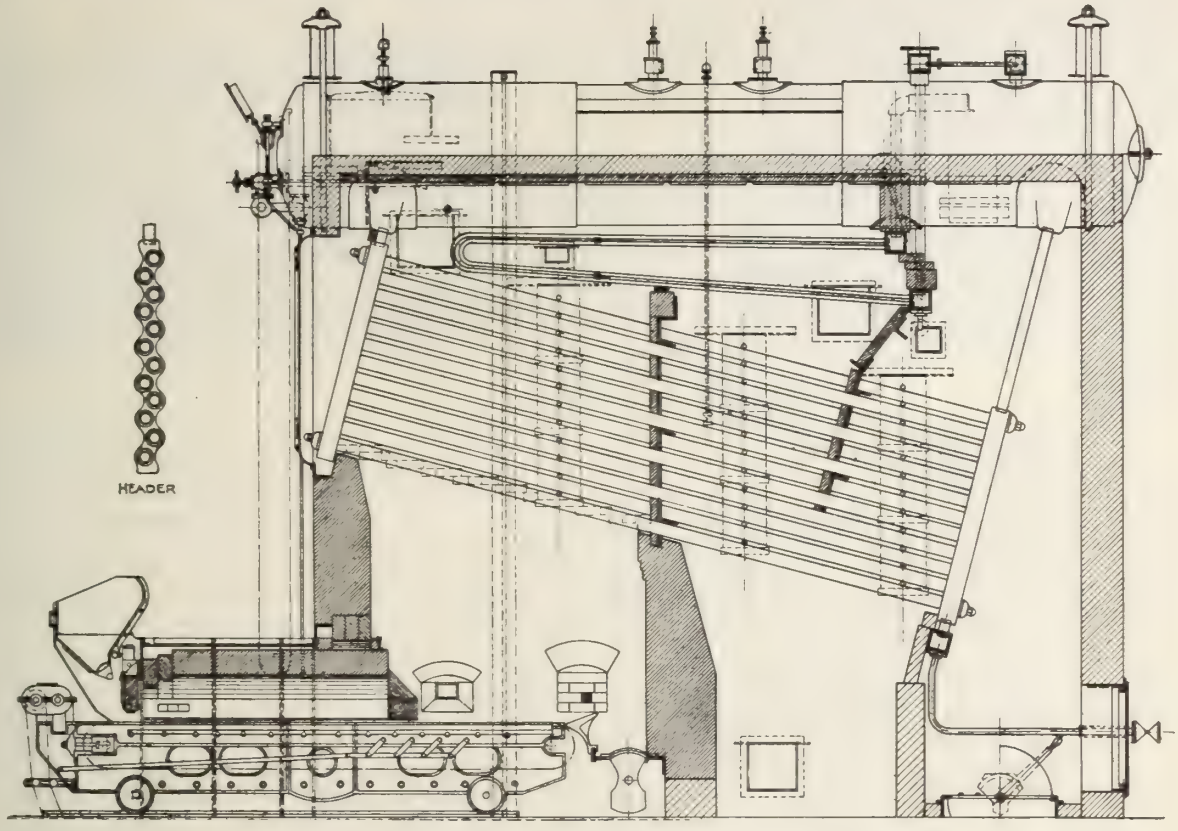
The liquid in the gauge glass on the absorber should show lots of liveliness. Dead liquid in the glass is usually a sign of foreign gases being present. The absorber should be frequently tested by the purging cocks to make sure there is no air or foreign gases present. The air will show in the usual way if the gas is discharged into a bucket of water by bubbling. Sometimes hydrogen is present in the gases, and this can be detected by opening the purge valve very slightly and applying a light to the end. If there is any hydrogen present it will light up.

In general, successful operation of an absorption machine depends on eternal vigilance even more than in the case of a compressor. Pressures and temperatures must be watched very carefully, and the levels of the liquid in absorber and generator kept constant. An absorption machine cannot be speeded up in the same manner that a compression machine can and attempts to force it lead often to trouble.

On the other hand the only moving part is the small ammonia pump, and this is usually large enough to admit of its being run very slowly. Very often these pumps are installed in duplicate so that there can be no shut down through

(Continued on page 34)

BOILER EFFICIENCY



Standard Longitudinal Drum Sectional Header Boiler

The laws of each province provide that every boiler operated within its boundaries must be built to certain recognized standards. All details such as seams, riveting, fittings, etc., must meet the approval of their inspectors before they will pass any boiler as safe to operate.

The Civil Law also states the lowest grade of engineer you can employ and how often he is required to prepare each boiler for inspection.

The lawmakers are concerned with the safety of the public, they do not make it compulsory for you to buy economical plant. You are expected, on your own judgment as a business man, to buy boilers which will give you the highest degree of safety and the greatest return for your money in pounds of water evaporated.

Now just as there are Civil Laws to make sure no unnecessary risks are taken by the public, so there are certain acknowledged engineering laws for the design and construction of economical boilers and furnaces. The success of all such equipment depends upon the success with which these laws, which safeguard your money, are applied—practically.

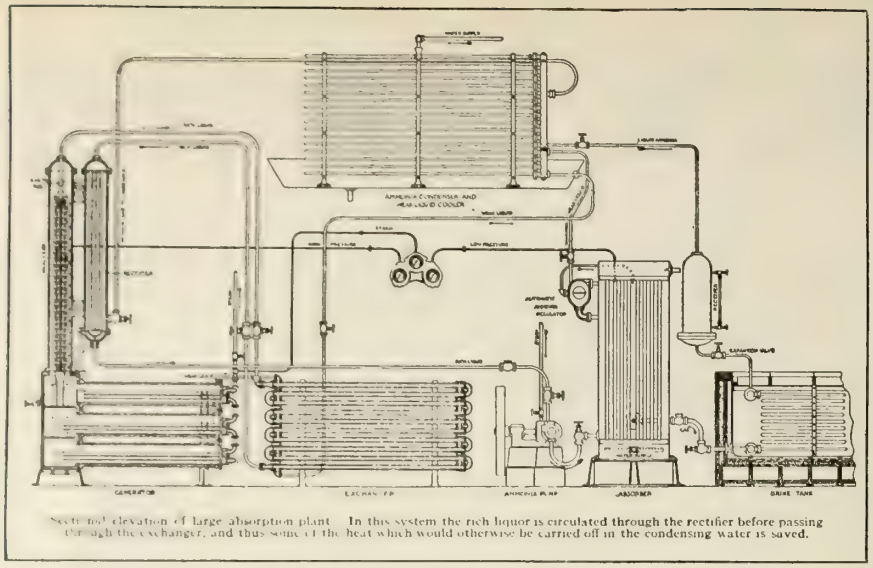
Boilers made by B. & W. are readily accepted by the authorities, even in the provinces with the stiffest requirements, because they are designed with a higher factor of safety than asked for, and no steam apparatus is made of better material or with more care. Every part is readily accessible inside and out, and with a responsible man in charge to see they are kept clean, there is little possibility of serious trouble.

As regards the efficiency of B. & W. steam plant, we can only ask you here to consider two factors—(1) THE EFFICIENT FURNACE because the fuel is fed evenly and intermixed with a proper amount of air while burning. Perfect combustion is produced and the fuel all gasified in the large combustion chamber before the heating surfaces are reached. (2) THE EFFICIENT HEATING SURFACE because of the proper circulation of the water and hot gases with reference to each other, and because they thoroughly interpenetrate each other, due to the arrangement of the baffles and the manner in which the tubes are staggered.

Babcock & Wilcox, Limited

Head Office for Canada: St. Henry, Montreal

Branch Office: Bank of Hamilton Bldg., TORONTO



Sectional elevation of large absorption plant. In this system the rich liquor is circulated through the rectifier before passing through the exchanger, and thus some of the heat which would otherwise be carried off in the condensing water is saved.

Diagram of Vogt Absorption System

REFRIGERATION FOR THE POWER PLANT ENGINEER

(Continued from page 32)

failure of the pump. If the system is a brine circulation one then the brine pumps will also be in duplicate. The exhaust steam from the pumps can be used in the generator coils. In the absorption machine heat is added to the ammonia liquid which is aborbed in the ammonia gas distilled from the liquid. Part of this heat is rejected in the rectifier, and the remainder in the condenser, but as the same water is used, it may be said to be all rejected in condenser. The heat rejected in the condenser is taken up again from the brine or room to be cooled. In the absorber meeting the gas and absorbing it develops heat, and this heat is carried away by the circulating water in the absorber coils. The principle is then the same as in any mechanical refrigerating process, that is, heat must be rejected at one part of the system and taken up at another. In the compression system the heat is added by the compression of a gas, the power required to perform this work being derived from a steam engine or a motor. In the absorption machine the heat required is derived directly from the steam, and if this steam would otherwise be allowed to escape to the atmosphere, a great economy is effected. The steam used to drive the pump can also be recovered and used in the generator. The absorption machine requires about double the amount of water that the compression machine requires, and this if water has to be purchased, is a very important factor. If a well can be bored and water secured for the cost of pumping, a great saving can be effected.

The choice between using a compression or absorption machine is one governed by conditions of location, type of plant, water supply, etc., and can only be determined for each individual installation, after considering every possible factor.

PRACTICAL ELECTRICITY

(Continued from page 29)

Only Positive plates are found in the Positive group, and Negatives in the Negative group.

Each group is burned solid to a Bus-bar, and the Pos. bus-bar is located at one side of the cell, whilst the Negative bar is on the opposite side of the cell.

Separators of either Wood, Glass Rods, or Hard Rubber are inserted between each Positive and Negative plate.

The whole is contained in either a large rectangular glass jar, or a hard wood tank lined with 3lb sheet lead, or in small hard rubber jars in case of the small portable batteries as used for automobile starting batteries.

Such are the simple parts that go to make up a storage battery yet what potentialities lay dormant within them!

The whole street car system of the City of Toronto, can be operated entirely by their storage battery plant, for a period of thirty minutes.

The large "K" class Submarines can be propelled for 300 miles when submerged, at a speed of about 12 miles per hour, entirely by their storage bat-

The Vacuum Tube on your wireless outfit depends entirely upon the storage battery for its successful operation.

Storage batteries are made in "vest pocket" sizes and increase in size until they weigh as much as 2-tons each cell.

It is important that we learn to distinguish between a "battery" and a "cell."

A "cell" is only a unit in a battery.

A "battery" is a number of cells connected together in series, so that the Voltage of each cell is added.

Composition of Plates

The composition of battery plates varies somewhat, as there are two generic types of battery plates.

(a) Plante plates.

(b) Faure plates

Gaston Plante (a Frenchman,) in 1860 discovered that by immersing two lead plates in dilute sulphuric acid, a thin skin of sulphate of lead was formed over each plate. This layer of sulphate of lead stopped all further action between the acid and the lead plate.

He then connected the plates to a D.C. source of supply and sent current through the acid.

It was then discovered that several changes took place. The sulphate of lead which had formed on the plate which was connected to the wire leading the current into the cell, was changed into Peroxide of lead, this being on the Anode.

On the opposite plate, which would be the Cathode, the sulphate of lead was changed into spongy lead.

Plante then connected these plates to a circuit through a resistance and discharged them. It was then found that the plate had once again become covered with sulphate of lead or lead sulphate.

This experiment was repeated several hundred times, and always with the same results, but it was found that as a result of continuing these Cycles of charge and discharge, the amount of lead Peroxide on the Positive plate, and the amount of Spongy lead on the Negative plate was considerably increased.

It will be obvious that such a process involves a very tedious and lengthy process of forming Lead Peroxide and Spongy lead.

If it were only possible to mechanically "coat or paste" these plates with Lead Peroxide and Spongy Lead, much time could be saved and expense reduced.

Another Frenchman, Faure, proceeded with this idea and made a skeleton framework of lead, into which he pasted the necessary Lead Oxides and achieved in a few hours what had hitherto required several months.

(To Be Continued)

Do Your Share To Prevent Fires

Every man should do his full share to prevent fires and to reduce Canada's fire loss, amounting to millions of dollars annually.

Almetl Fire Doors and Shutters will give your plant the greatest protection against the spreading of fire.

The **Almetl** is built of corrugated steel interlined with asbestos and will withstand the most intense fire without twisting or buckling.

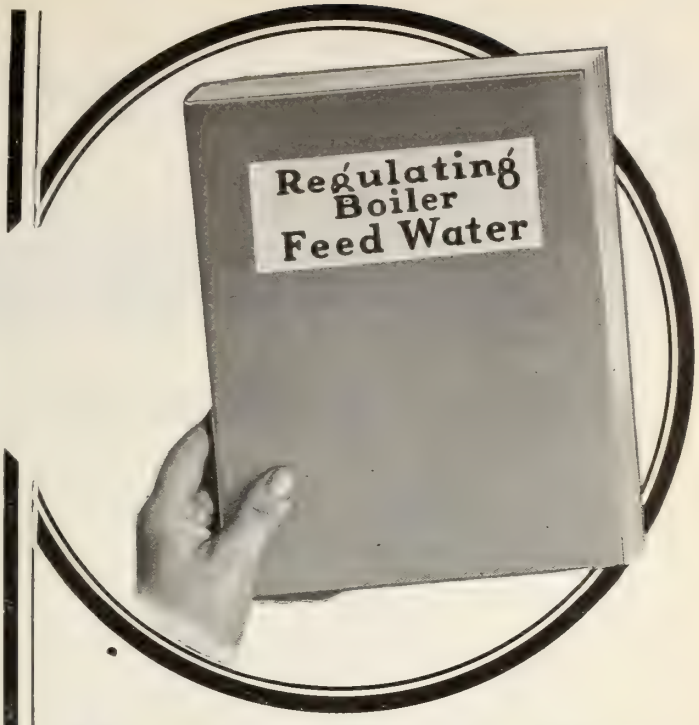
Reed's Fire-Tite oily waste cans should be in every factory, mill, power plant and garage, wherever waste is used. Built of steel, with light stork legs and self-closing lid, they are positive against spontaneous combustion fires from oily waste.

Made in three sizes.

Almetl Fire-Doors and Fire-tite oily waste cans bear the Underwriters' Label.

Write for particulars.

Geo. W. Reed & Co.
LIMITED
MONTREAL



This Free Book Shows how you can save on your fuel bill—

Our latest book—just off the press—shows how fuel savings ranging from 2% to 8% are being made in many plants, simply by improvement in feed water regulation.

The first part of this booklet, written by a prominent authority on power plant engineering, gives most excellent ideas about what feed water regulation ought to be, mechanically.

Then follow some unusual charts, showing in an interesting way the effects of different methods of water feeding on boiler efficiency.

This book will prove very helpful to any power plant engineer or manager who is interested in saving fuel, and eliminating waste. We will be glad to send you a copy, without charge or obligation.

To save your time, just write your name on the coupon, pin it to your letterhead, and mail it to us.

NORTHERN EQUIPMENT COMPANY
112 West 11th St.
Erie, Pa., U.S.A.

COPES

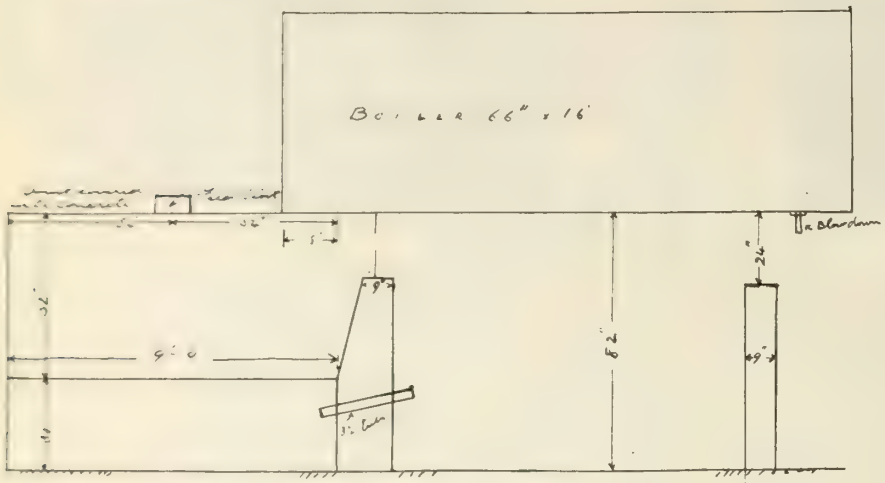
NORTHERN EQUIPMENT CO.
112 West 11th St., Erie, Pa.

Gentlemen:

Please send your new Booklet D, on "Regulating Boiler Feed Water," without charge, as advertised in Power House.

Name .....
Company Name .....
Address .....

The Operators' Point of View



Outline of Dutch Oven Setting

DUTCH OVEN DESIGN

By W. H. Long

The accompanying illustration shows the Dutch oven boiler setting which I have installed in the plant of which I am in charge, and which is my own design. It is operating at 138 per cent. rating, and giving perfectly smokeless combustion.

Before the changes were made the boilers were giving 78 per cent, rated capacity, and I was given a free hand to make any change I saw fit.

On examining the boilers I found that the combustion chambers were filled with gravel, so that it was impossible to crawl under them. The bridge wall was just ten inches from the shell. The feed chutes for the sawdust, etc., were too far back. I, therefore decided to tear out the old ovens, and build new ones as shown in the sketch. The tube through the bridge wall is to carry air to the combustion chamber to complete combustion and it is a decided success. The fuel I am using is sawdust and trimmings. I would advise anyone who is using Dutch ovens to clean out combustion chamber and put in the pipe as it will help them greatly.

FILING SYSTEMS FOR ENGINEERS

Readers of Trade-Journals are often invited to send in their suggestions, as to how the publication may be made more interesting and helpful. One journal recently sent out a circular letter stating "we can get anything that our subscribers want, if we know that enough of them want it." The purpose of my letter is to explain a need or "want" of every ambitious stationary engineer, and the solution is quite within the reach of all at little expense. The publishers I think can do much to facilitate my scheme and incidentally make the publication "Power House" of greater value not only to the reader but to the advertiser; 1st by arranging the reading matter topically; 2nd, by a classified arrangement of the advertising, as far as it is practicable.

If the engineers realized the many advantages of having and keeping an "up-to-date" Topically Indexed file for handy reference, they would not be long in expressing their "want" or need; especially as same may be procured at a very moderate cost and kept up to date with very little time and effort.

The purpose of the Vertical —Indexed Topical—file suggested is to preserve articles of interest and usefulness clipped from Power House; also ads description of new apparatus or appliances. It is a peculiar fact that most engineers eagerly read all the advertisements in Power House because they are a ready source of information to the engineer who is anxious to better operating conditions in his plant. The first requisite for Topical filing is a telescopic-file, preferably a vertical one, either letter-size (8½ x 11½) or Legal-size (9x14) which the average engineer could make himself at little expense and buy re-inforced blank tabs, for the purpose of Indexing. However, there is a well known make of Vertical-telescopic indexed-files on the market which may be obtained for the purpose at $1.25 to $2.50 each depending upon the quality and size of case. Once in the possession of such a file, its value and usefulness is soon proven. A traveller calls, and hands the engineer a pamphlet on Feed-Water-Treatment (Scale and Boiler Compounds), which he promptly files under the heading of Water-Treatment; he next looks up a reference book to find a solution for the trouble he has encountered in connection with the use of boiler (H.W.) Return Traps. He then makes a sketch of the trap and its connections on a sheet of paper suitable for filing, notes what is said in the reference book as to the probable cause of the trouble (failure of check-valves to seat, etc.) and carefully files this information for future reference under the heading of Traps. In this way notes on any subject particularly those made while attending the educational meetings of the C. A. S. E. should be carefully filed; likewise information obtained from experienced engineers' descriptions of new power plant apparatus or equipment. The following general classification of subjects for Topical filing may be added to meet the requirements of each individual case.

A—Air-cooled cylinders, see engines and compressors, air-brakes, etc.

B—Boilers, boiler setting, brick work, brake test, boiler regulations.

C—Condensers, compresors, combustion, coal (origin and analysis).

D—Draft-indicators, damper-regulators and recorders.

E—Evaporation and expansion of gases, steam, etc.

F—Fuels, flame, firing vs stoking, filters and purifies, fans.

G—Grate-bars, gas engines (see internal combustion).

H—Heating (see radiation); Horse-Power equivalent, etc.

I—Internal Combustion vs. External Combustion Engines etc.

J—Judging the best kind of material or equipment, comparative.

K—Kinds of fuel, for what purpose or service each is best suited.

L.—Lubrication of cylinders and machinery—laws re.

M.—Metering pres. and flow of water, steam, elec., gas, oil, coal, etc.

N.—Natural draft vs. forced or induced and smoke prevention.

O—Oxygen (see combustion) oil and greases; overload capacities.

P.—Pumps, piston rings; pipe sizes, covering and capacities.

(Continued on page 38.)

Mr. Manufacturer—

Is this hint from a reader Worth anything to you ?

A STRIKING message to manufacturers of power-house equipment is derived from a letter written by a "Power House" reader in reply to a request for a criticism of the paper and for suggestions as to how it could be improved. In asking for criticism it was to the editorial portion of the paper rather than to the advertising that reference was intended, and there was no expectation of eliciting such a remarkable testimonial to the paper's efficiency as a medium of publicity. This spontaneous tribute should therefore have a doubly convincing effect. Here is the letter:

Circulation Manager Toronto, April 8, 1922.
Power House.

Yours of April 5, 1922, to hand asking for my candid opinion about Power House. Any opinion other than an honest one is worthless and some parts of the following may not be just to your liking but it is at any rate honest.

I believe Power House compares favorably with other power-house journals in many respects. One department I would like to see at least three times its present size is the selling section. Many of the ads. are from all-American U.S. firms but there must be many others, some of them with Canadian branches and agencies, who do not carry an advertisement in Power House. **This is a mistake on their part,** but for all I know to the contrary it may be due to the lack of energy on the part of the Power House ad. manager in getting after them. **It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages SO MUCH AS ON THE ADVERTISEMENT PAGES.** I write from experience. For the past twenty years I have been first engineer in different government-owned power-plants and I have, time and again, secured ideas tending towards improved conditions in power-plant work from the selling section of Power House. The buyers' directory is good, I would like to see the advertisers index several more pages....."

Suppose you were asked—

by an engineer to tell him something about your products—you would jump at the chance, of course. Well then, do you realize that twice every month some 4,000 such men—men vitally interested in your products—are literally **asking you** to tell them something about your products. That is why these men subscribe to "Power House" (a Canadian journal devoted entirely to Power Plant Efficiency in Management, Equipment and Operation), because they want to know in just what way **your products** will benefit them. **Why don't you tell them?**

We offer you the experience of our Advertising Service Department for the preparation of your messages; in fact for everything from specific information to the planning of an entire campaign. Make use of us; but, before everything else, properly appreciate the unique value of Power House as a medium and make use of it.

POWER HOUSE

143 UNIVERSITY AVENUE **TORONTO, ONT.**

OPERATOR'S POINT OF VIEW

(Continued from page 36.)

Q.—Questions, for the educational committee of the C. A. S. E.

K.—Kinds of fuel and service each best suited for.

L.—Lubrication of cylinders and machinery—laws, etc.

M.—Meters, pres. and flow of water, steam, elec., oil, coal.

N.—Natural draft vs. forced and induced (smoke prevention).

O.—Oxygen (see combustion) oils and greases (see lubrication).

P.—Pumps, piston rings, pipe capacities and covering.

Q.—Questions referred to the educational com. of C. A. S. E.

R.—Radiation, heat insulators, radiators, refrigeration.

S.—Steam engines and turbines, steam heating.

T.—Tables and equivalents, temperature (latent and sensible heat).

U.—Uniflow—gas and steam engines, underground Ste. Mains.

V.—Ventilation—Valves, venturi, variable speed control.

W.—Water-filters and treatment, water-wheels, fly-wheels.

X.—Copies of daily boiler and engine room reports and charts.

Y.—Copies of the weekly boiler and engine room reports and charts.

Z.—Copies of the monthly boiler and engine room reports and charts.

No doubt there are more elaborate and complicated systems in use for filing subject matter, but I have tried to outline the one which I have found to be the simplest and best. Hoping the idea outlined above will be found helpful to engineers, I am

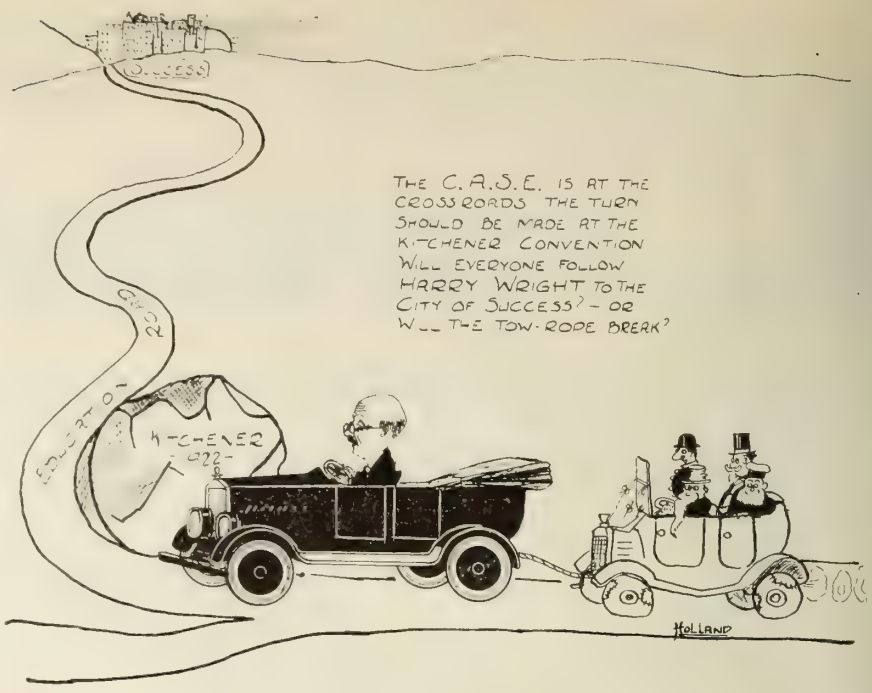
Yours truly,
Geo. J. Soucy,
(2158 Gerard st., E.)

C. A. S. E. MATTERS

The Editor, Power House:

I thank you for the space afforded my letter on the Inter-Provincial Certificate. I must ask you again for the space to comment on your Editorial Note of the coming Convention of the C. A. S. E.

I, like yourself, have seen for the last few years, that the C. A. S. E. has been lacking in leadership and organization, and that it has been trying to serve two masters. We are taught from early childhood that we cannot serve God and Mammon, so also we cannot run an Educational Society on Fraternal Society lines. You have either to co-operate with Capital or you must come out in the open and declare that you are against it, that is why, in my opinion the C. A. S. E. has been at a standstill the last ten years or more. The time has now come to modernize it and carry out the preamble to the letter, or scrap the preamble and declare you are out for the dollars and cents by force. This way never paid and will not do so in the future, if we are to get down to normal conditions again.


THE C.A.S.E. IS AT THE CROSS ROADS THE TURN SHOULD BE MADE AT THE KITCHENER CONVENTION WILL EVERYONE FOLLOW HARRY WRIGHT TO THE CITY OF SUCCESS? - OR WILL THE TOW-ROPE BREAK?
HOLLAND

The spirit of progressiveness you speak of is certainly stalking abroad, and if given the right support, its authors will certainly carry it through to a finish, but it must have undivided support, otherwise the revolutionizing falls flat, and it goes on in the old rut.

I was asked some time ago, when in front of the Canadian Manufacturers' Association, "How do you account for so small a membership after being 30 years formed." I replied very promptly that "Lack of leadership and organization and trying to combine two principles entirely opposed to each other, was the cause," and they agreed with me. The only remedy is to alter the Constitution to suit the aims, leave secrecy behind and come out in the open to educate your fellow man. This has led to contemplation of some very drastic changes at the coming convention, whether the C. A. S. E. members will have the foresight and stamina to carry it through remains to be seen. My reason for writing so plainly is, that there are a great number of engineers I will not be able to reach except through the columns of your paper, and I think that when the matter is explained to them in the proper light, they will be in a position to judge, and I know all sane and right-minded engineers will agree that both you and I are right and that a step has been taken in the right direction to bring the operating engineer to the place he rightly belongs to in the professional world.

I don't think it will be necessary to have a new charter, it can still remain the C.A.S.E. only it can be run on the lines of a purely educational society. In my different circular letters to the various lodges, I have gradually led up to that drastic step, for I was firmly convinced that it had to be approached very cautiously, otherwise the members would have looked askance at so large a proposition being suddenly thrust upon them. I think that a little more co-operation with the Western section of engineers will go a long way toward accomplishing the aims and progress of the C.A.S.E., also a little more infusion of technical engineers in its ranks. These people have been refused recognition in the past by the C.A.S.E. but the time is not so far distant when it will be necessary for this co-operation, unless our members want the association to remain an unknown quantity, as it is to-day.

Again thanking you for past favour,
HENRY WRIGHT, A.M.E.I.C.,
Vice-President of the C.A.S.E.

Editor, Power House:

Dear Sir:

In reference to your more than interesting article on the above society in "Power House," of May 20th, the writer endorses your remarks, particularly the secret society part. It is very unnecessary and takes up too much valuable time and is too formal.

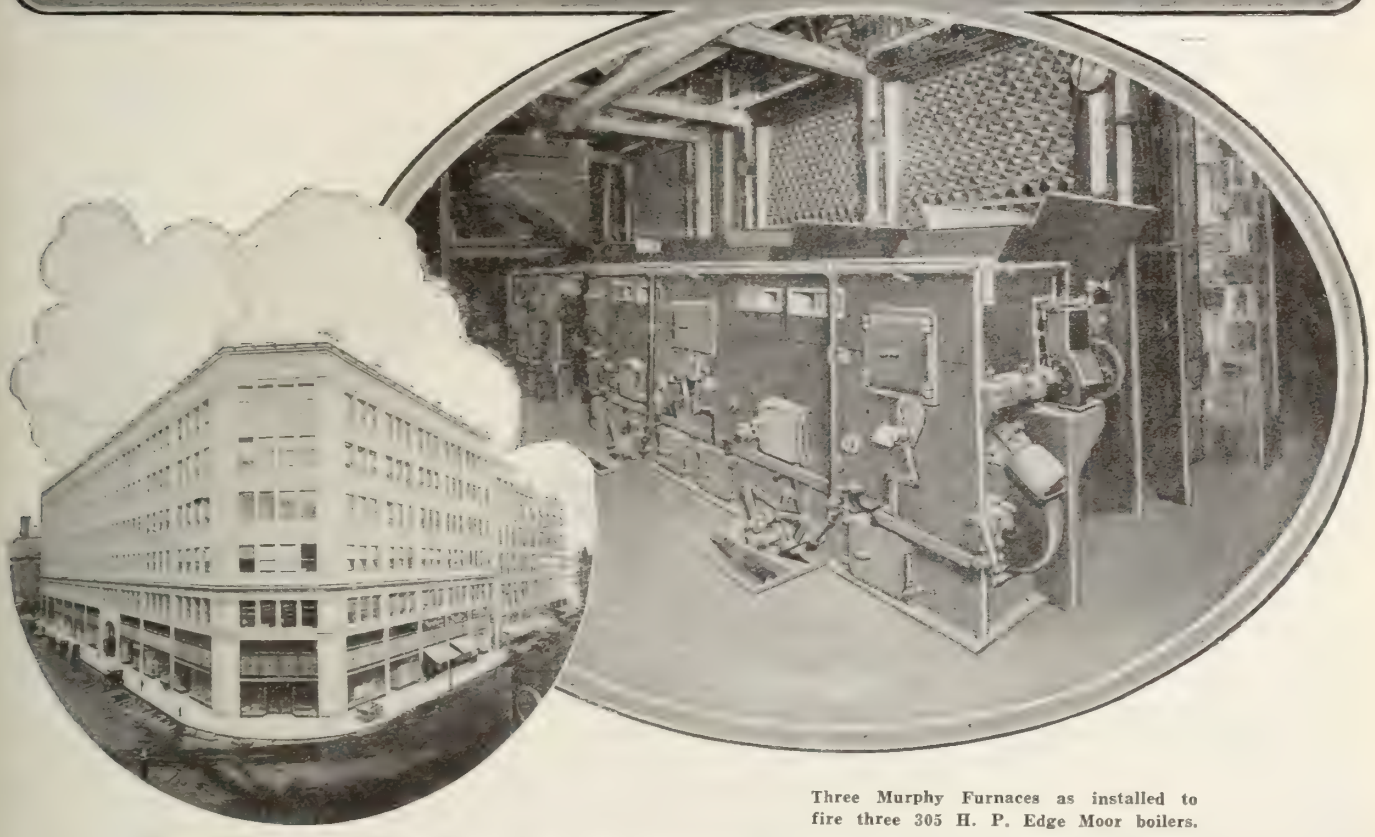
The Canadian Institute of Engineers and similar societies merely pass the minutes of previous meeting and elect members who have been ably scrutinized by the council. I would like to make a few suggestions through the columns of your influential journal as one cannot bring up a whole batch at any one meeting. Moreover it might appear to be too drastic for some. The writer has had twenty years' experience in organizing similar society work and it was our own experience from year to year, that by being affiliated with similar societies that one can make progress.

Amongst many alterations suggested for more able pens than mine to take up a few are the following:

To elect a stalwart president such as

(Continued on page 40)

221 MURPHY FURNACES
INSTALLED IN
72 OFFICE BUILDINGS



Three Murphy Furnaces as installed to fire three 305 H. P. Edge Moor boilers.

For office buildings the first requirement for stoking equipment is that it must not emit black smoke through the chimney nor obnoxious gases in the boiler room to circulate up through the building.

St. Paul's newest and finest office building, the Hamm Building—in selecting

MURPHY AUTOMATIC FURNACES

for their power purposes is assured tha t the above requirement will be met.

Here's the process that makes the Murphy smokeless. As the coal enters the furnace it rests for a short time on the coking plate. There the volatile gases are driven off and immediately mixed with the heated air admitted through the arch plate air ducts, forming a combustible gas which is burned as it passes toward the rear of the furnace. The fuel travels slowly down the inclined grates toward the clinker grinder, receiving the requisite amount of air through the grates to complete the burning process. *221 Murphy Furnaces installed in 72 office buildings, a total of 36,679 B. H. P.*, indicate that they have made *good* in this field.

If saving 15 to 30% of your coal bill interests you along with other advantages, write to-day for Catalog H-4.

MURPHY IRON WORKS
DETROIT, MICHIGAN

SANFORD RILEY STOKER CO., Owners, Worcester, Mass.

RILEY UNDERFEED STOKERS

BRANCHES
BOSTON NEW YORK PHILADELPHIA PITTSBURGH
BUFFALO CLEVELAND CINCINNATI CHICAGO

AGENTS
Beeson Machinery Co., Kansas City Stearns-Roger Mfg. Co., Denver Col.
Robinson, Cary & Sands, St Paul Minn

C. A. S. E.

(Continued from page 38)

some leading professor or some leading engineer.

A president designated.

A list of vice-presidents connected with the profession only.

A list of honorary members to be elected annually but not able to vote on direct work of the society.

If any ordinary member relinquishes his profession to be a representative he should then become an honorary member and subject to re-election.

A chairman and vice-chairman of the council where all the work of the society could be ably discussed and presented to each meeting for ratification.

Circulars should be sent to every meeting stating business. List of members' arrears, also all candidates, their proposer and seconder with all three addresses and names of firm by whom they are employed.

An annual diary should be issued gratis to every member only, giving names, address of home and their firm with telephone No. This might be done at a profit as no doubt many engineering firms would gladly take a page or more for advertisements.

More time for smoking and it would add socially if tables were used to sit around to get closer together.

A secretary and treasurer both to be paid. An assistant secretary and recorder.

A council of 7 with the secretaries and ex-officio members and the two making lowest number of attendances to ultimately drop out, but subject to re-election. Sub-committees could be arranged in the usual way but to report to council who would then report to the meetings to affiliate with similar societies and to join in their visits and excursions.

To arrange visits to cities and places of interest, say once per month in the evenings and one on Saturday afternoons and one day's excursion per year to visit large works, etc.

This need not interfere with the social rite as now carried on.

The social rite is the acme to aim for to make any society a success.

To aim at securing a room to themselves and to be open two or three nights per week, especially Saturday evenings in the winter months.

Papers should be read as far as possible by their own members.

Members should be elected similar to any other kindred societies, that is, only 1st and 2nd class engineers to be ordinary members and 3rd and 4th associates.

Ordinary members only to vote on society work.

WOODSTOCK LODGE C.A.S.E.

On Friday evening, June 8th, the members of Woodstock Lodge, No. 37, met to elect the officers for the coming year. The installation was performed by Past President Bro. Arnupp. The officers elected and installed were as follows:

President, Bro. Precious; Vice-President, Bro. G. Diron; Rec. Sec. and Treas., Bro. Geo. S. Linnell; Fin. Sec., Bro. Ross; Conductor, Bro. Angus; Doorkeeper, Bro. Meredith.

In addition to the above, Bro. Arnupp was chosen as the delegate of the lodge to attend the Grand Lodge at the Kitchener Convention.

After the business of the evening was concluded, the time was spent in social activities. The lodge looks forward to a year of great and productive activity.

INTERPROVINCIAL CERTIFICATE

Editor, Power House:

Dear Sir:

If space permits would you kindly publish the following in your valuable journal:

First, I want to thank Mr. Henry Wright for his work and timely suggestions towards the issuing of a Dominion-wide certificate for Canadian engineers.

His proposed system of issuing cards may work very satisfactory, but I would like to submit another plan which I think would simplify matters very much.

After a board of representatives of the different provinces have got together and agreed on uniform regulations, (the same as was done in the case of the inter-provincial boiler regulations) a standard form of certificate, for all grades, should be issued to every engineer, holding a provincial certificate, in exchange for his old one, the new being graded the same as his old one, and on paying of a small fee to the provincial government to cover expenses, which I think, would not exceed a dollar for each certificate.

A suggestion with reference to the certificate:

I would like to see the new certificate head-lined something like this:

CANADIAN INTER-PROVINCIAL CERTIFICATE
First-Class Stationary
Issued at
REGINA, SASKATCHEWAN, ETC.

I think the words, Canadian Inter-provincial, should appear prominently in the headlines. The grade and class such as stationary, hoisting or traction, and the place of issue, of course, to be varied in each individual case.

Such a certificate would at once be recognized by all concerned, and would do away with the more expensive card system as suggested by Mr. Wright, and of the continually issuing of cards to moving engineers. It would be less confusing to the public and to the enforcers of the law.

This plan would in no way interfere with the provincial rights or revenues of the inspection staff, as the cost of the certificate and examination in any grade would be uniform in all the provinces and all monies be paid to the respective provincial governments the same as at present

If all the provinces could not agree on uniform action at once, that should not delay the carrying out of the scheme, but as soon as two or more provinces agree it should be started.

I am convinced that it would not be long before the others would see the benefit to all concerned and soon would join.

The difference in the existing examinations in the various provinces at present, seems by some, to be held up as a barrier against the issuing of a uniform certificate, should, as Mr. Wright points out, be considered only as ground for "petty quibbling," and not be allowed to hinder the progress of the good work at all.

As to the difference in horse power allowed on second and third class certificates in different provinces, it should not be very difficult to adjust as that was only an arbitrary matter in the first place.

Now I want to thank "Power House" for its editorial stand and its liberal space given to correspondents on this question, and I hope it will continue to keep up the pressure until the desired results are obtained.

For I see in it also greater benefit to "Power House" which will then, more so than now, be a medium in which the engineers and employers from all over Canada can meet to express their respective wants.

SASKATCHEWAN ENGINEER

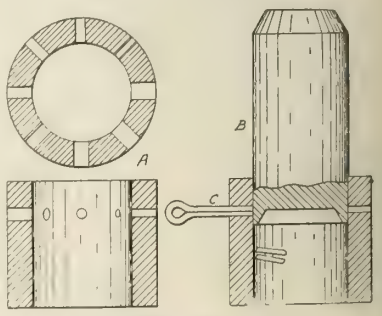
GRAPHITE AS BOILER SCALE PREVENTIVE

Tests are being made at the Southern experiment station of the Bureau of Mines, Tuscaloosa, Ala., to determine the efficacy of low grade dust from Alabama flake graphite for preventing the formation of scale in boilers.

CUTTING SPLIT PINS

By W. J. H.

The accompanying sketch shows a handy tool for cutting short pieces off split pins and small rods. The piece A is made of 2 in. cast steel bored to about 1¼ in. and having a series of different size holes drilled through the wall. These could be drilled in irregular positions if desired. The punch B is turned to fit the bore of the ring and cupped at the cutting end as shown. A light blow of a hand hammer is sufficient to cut the average split pin.



Cutting split pins

FIVE CONSIDERATIONS THAT MAKE GARLOCK NO. 900 SHEET UNQUESTIONABLY SUPERIOR

1. **Quality**—Made only of highest grade materials.
2. **Service**—Maintains a steam tight joint against the highest degree of superheat met in modern practice.
3. **Adaptability**—Is equally serviceable for air, acids and ammonia.
4. **Economy**—A joint that must be frequently opened can be remade many times, using the same gasket.
5. **Reliability**—Garlock No. 900 imprint with our trade mark is assurance of dependability.

We cut gaskets, Style No. 950, in all shapes and sizes, from Garlock No. 900 Sheet.

GARLOCK NINE HUNDRED SHEET

GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY,
HAMILTON, ONTARIO

Branches:

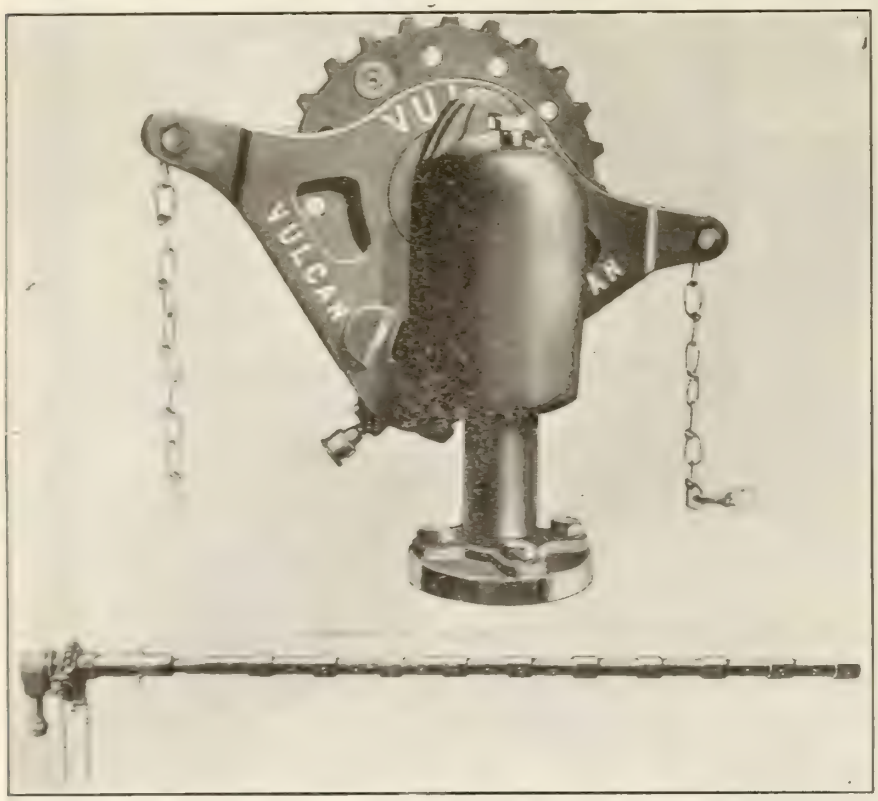
Montreal, Que. Toronto, Ont. Winnipeg, Man.
Calgary, Alta. St. John, N.B. Vancouver, B.C.

Progress in New Equipment

NEW VULCAN OPERATING HEAD

The new operating head announced by the Vulcan Soot Cleaner Company is known as the Ratchet Operating Head, illustrated in Fig. 1, the basic principle of which is automatically to limit the sweep of the soot-cleaning element, to force the operator to operate the element in a step by step movement, and hence to insure that the steam jets have an opportunity to sweep over and throughly clean every part of the tube surfaces.

For many years, a small percentage of soot-cleaner owners has complained that soot cleaners did not thoroughly remove the soot accumulations. Investigation disclosed, in a majority of these cases, that the cleaning elements either were being rotated too fast, or rotated by careless workmen through only a fraction of the full permissible sweep of the elements. As a result, the cleaner was prevented from doing its proper work, through failure to give the steam jets time enough thoroughly to clean the tube surfaces.



Vulcan Automatic Head

To correct this difficulty, to make soot-cleaner operation more mechanical and less dependent upon the efficiency of the human factor in the boiler room, the new Vulcan Ratchet Operating Head was designed and is now being placed upon the market.

The new head is so constructed that when the operator pulls the chain the element is rotated only a short distance, and can be turned no farther until the ratchet frame has been returned to its original position. Then, and only then, a pull on the chain causes the element to rotate another space. Between the lulls in operating the new head, the steam jets have an opportunity to concentrate upon a definite section of the tube surface for a length of time sufficient to insure a thorough removal of the soot. When the complete arc of rotation has been attained in one direction, which is limited by "stops" especially set for that purpose, the mechanism automatically reverses itself and the cleaning element moves back in the same manner through the same arc. Any soot that may have re-deposited after the first rotation is completely removed on the backward travel.

In designing this ratchet operating head, the Vulcan engineers kept constantly before them the fundamental purpose of every soot-cleaning apparatus, namely, to remove the soot thoroughly, and built their operating head with this purpose only in mind regardless of the competency of the individual doing the actual work of handling the equipment The net result is a device that takes the control of cleaning entirely out of the hands of the operator, and places it solely in the ratchet operating head.

The Vulcan ratchet operating head possesses five features of paramount importance to the power plant engineer. These are:

(1) It absolutely prevents the man operating it from neglecting any part of the complete sweep of the cleaning element;

(2) It substitutes a uniform rate of speed of rotation, in a step-by-step movement controlled almost entirely by the head itself, in place of the old irregular, uncertain rate controlled by the whim of the operator and his desire to get through with the job as quickly as possible;

(3) It assures a considerable saving in quantity of steam used, because the operator knows that he has to make the sweep only once in each direction and can stop when that has been completed;

(4) It provides the operator with a clearly defined task, instead of a vague and indefinite one;

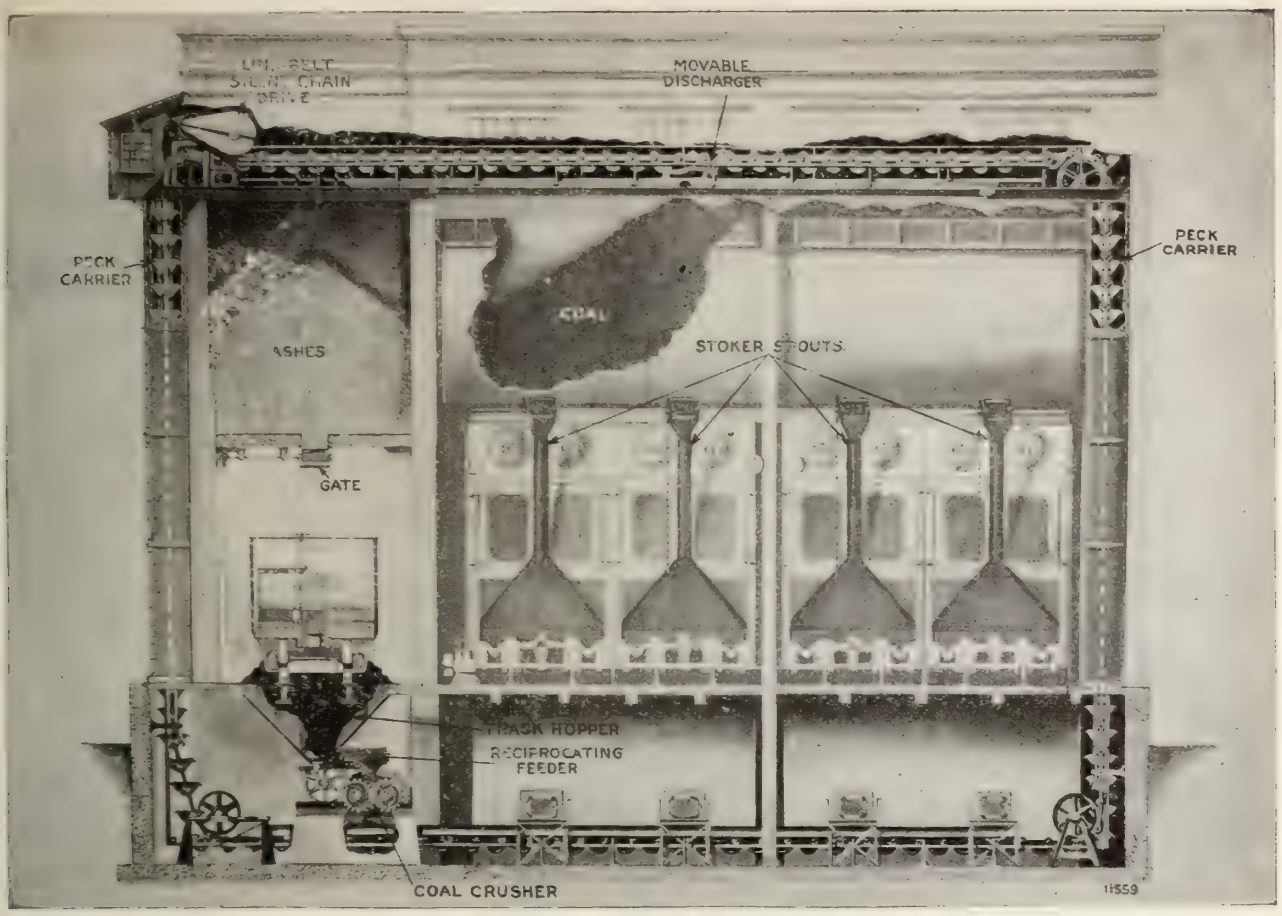
(5) Above all, it entirely eliminates wrong methods of soot cleaning, and is an assurance of more satisfactory and thorough cleaning results.

The new head, as may be seen from the illustration, is remarkably simple and strong. Its action is positive and sure. There is not a part to slip out of place, and thereby throw the whole device out of action. The chain is securely riveted to the ends of the ratchet frame and no amount of pulling or jerking will tear it loose.

This new Vulcan ratchet head is operated independently of the valve. Therefore, should the element operating mechanism accidentally fail during operation the whole cleaner system is not put out of commission while repairs are being made. The value of a soot cleaner depends upon its usefulness. If the temporary failure of one cleaning element means that the whole system is out of use until that one element has beeen repaired, then, obviously, the real value of the cleaner is seriously impaired.

Fig. 2 illustrates a Vulcan sheathed

(Continued on page 44)



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NEW EQUIPMENT

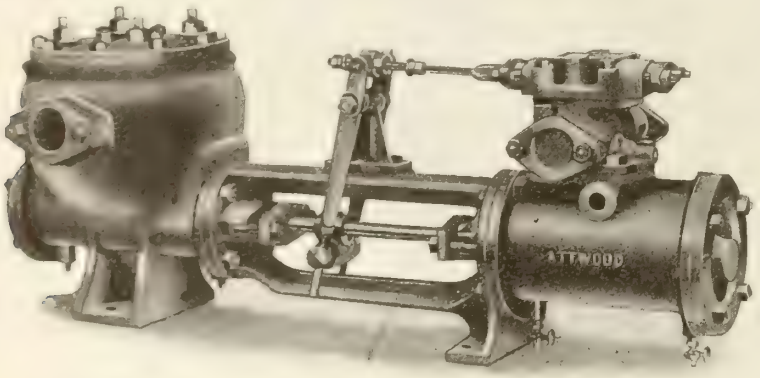
(Continued from page 42)

element, designed for a Stirling or Erie City vertical boiler, completely set up and equipped with the new ratchet operating head. The large tube between the head and the element is the wall sleeve, which is securely bricked into the boiler wall, and through the element passes to be screwed into the hub of the ratchet head. Two set screws in the ratchet wheel hub anchor the element in place.

A vitally important feature of the Vulcan element is the use of sheathing to protect the element from the high temperature gases in the first pass of water tube boilers. First comes the cleaning element itself; over it are placed short lengths of a special grade of cast iron sheathing, loose to allow for expansion; between, but overlapping the sheathing pieces, is an expansion piece, also loose; nozzles are screwed through the expansion piece directly into the element, and also, in elements designed for the Stirling type boiler, through the sheathing between the expansion pieces, as illustrated. This method of protecting elements is particularly successful in prolonging the life of elements constantly subjected to high temperatures.

THE ATTWOOD STEAM PUMP

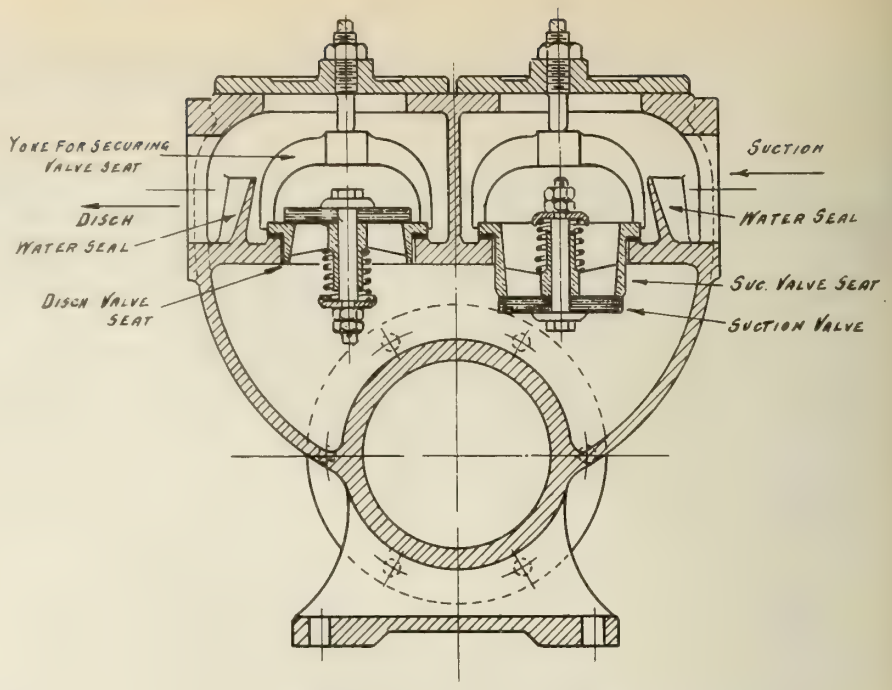
We mentioned in a recent issue of Power House that a new type of pump had been designed by Mr. Attwood of Toronto, and that we had been present at a demonstration of this pump. We are now enabled to give illustrations of this new departure, and our readers can see for themselves the construction of the water end of the pump, which differs materially from the generally accepted design.



The Attwood Pump.

There are two things in particular which are claimed for this pump, which will appeal to the operator. One is the ease with which valves can be examined and repaired, and the other is that the pump is always kept primed by reason of the suction pipe being situated above the suction valves, a seal thus being always present.

The sectional view will show how simple a matter it is to remove the valves, and seats, when repairs are necessary, such as renewing a disc or rubber valve.



Section of Water End Attwood Pump

It is claimed that the construction of the pump also makes it a much more efficient pump for vacuum purposes in connection with vacuum heating returns than the ordinary design of vacuum pump.

The direction of flow of the pump can be reversed by simply changing the suction valves over to the place occupied by the delivery, and vice versa. The design of the pump is neat, and makes for strength with a minimum of weight.

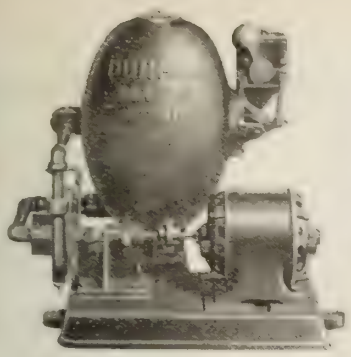
The steam end of the pump is fitted with Attwood's Improved Positive Valve Motion, which makes it impossible for the pump to short stroke under any conditions, and prevents it from stoping as long as steam is turned on. The cushioning of the piston has beeen provided for in an effective manner. The stuffing box on the piston rod has been made deep, so as to enable an ample amount of packing to be fitted, minimizing the possibility of steam leaks at this important point.

The pump is being manufactured by the Atlas Engineering Machine Works, River Street, Toronto.

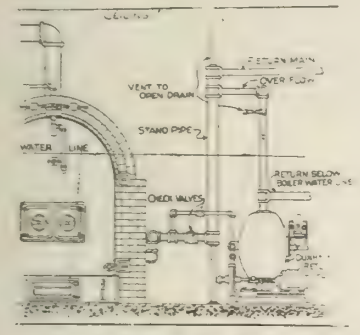
SAFETY CUP LOCK

An interesting type of safety nut lock has recently been placed on the market. The bolts used in connection with the safety cup lock are similar in every respect to standard bolts excepting that they have a square grooved end into which the tongue of the lock fastens. This square end is a decided asset because it enables the bolt to be driven clear out of the hole without the slightest injury to the thread. Highly polished, semi-finished and case hardened nuts need not be used, for the safety nut lock protects, in fact strengthens the nut considerably; therefore a plain cold punched or hot pressed nut of any standard make can be used most satisfactorily and with greater security. The cup is fastened on the square grooved end of the bolt and has no contact whatever with the threads of the bolt or the nut. It bears most of the pressure strains, instead of throwing them on the threads of the nut or bolt. The length of the cup allows considerable play for the nut, and if the nut is covered by only one-half or three-quarters of the cup, it is as firm and secure as if it were covered completely; thus the use of washers is eliminated. It is claimed that it can be used over and over again. The cup part of the safety nut lock takes the place of a jam nut, when it is desired to remove or tighten stud bolts. It can be put on and taken off very easily, without affecting the threads, bolt or nut. This nut lock is manufactured by the Interlocking Lock Washer Co. of New York.

The most satisfactory method of braking employs an electric release of the magnetic or solenoid type, as it is automatically switched in and out of circuit with the motor, any interruption to the current causing it to act insantly.



The Dunham Return Pump
Type R.L.P.



Application of the Dunham
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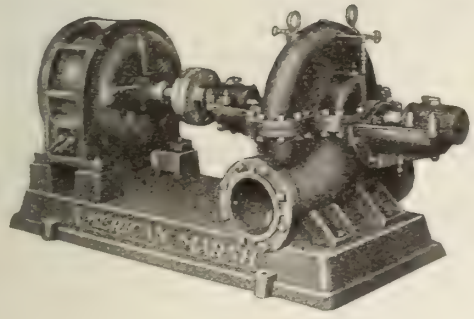

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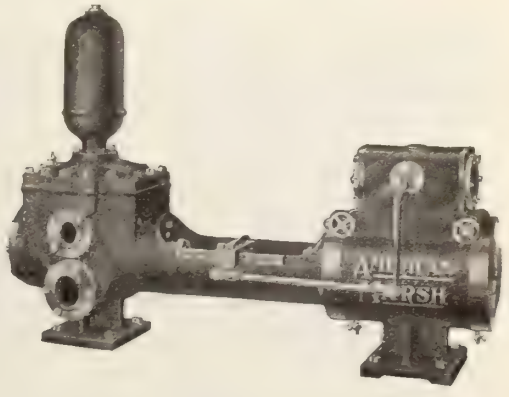

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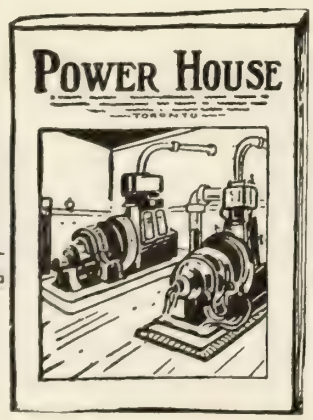

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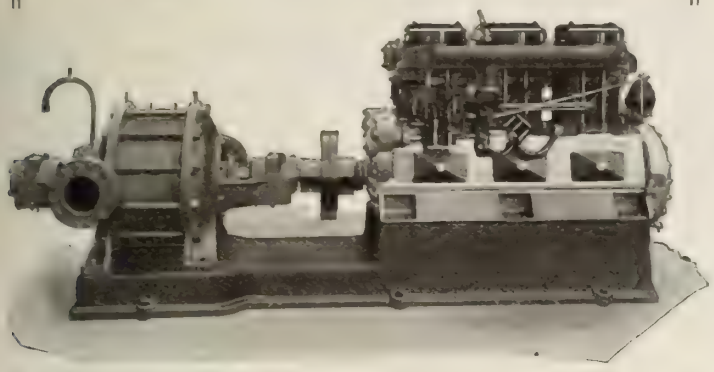

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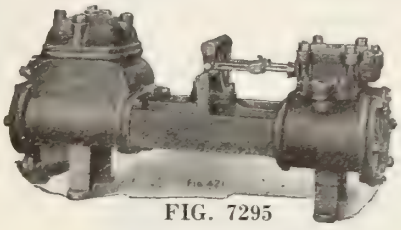

FIG. 7295

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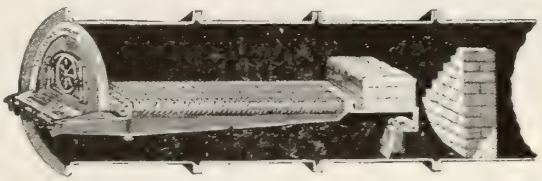

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"I believe Power House compares favorably with other power-house journals in many respects. One department I would like to see at least three times its present size is the selling section. Many of the ads. are from all-American U.S. firms but there must be many others, some of them with Canadian branches and agencies, who do not carry an advertisement in Power House. **This is a mistake on their part,** but for all I know to the contrary it may be due to the lack of energy on the part of the Power House ad. manager in getting after them. **It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages SO MUCH AS ON THE ADVERTISEMENT PAGES."**

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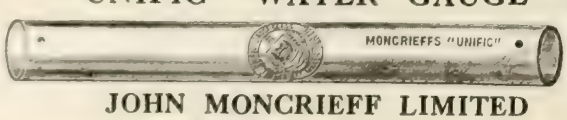

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"Joy Shots" That Lead to Hell

By JUDGE EMILY F. MURPHY (*Janey Canuck*)

THIS IS the first of two articles in which Judge Murphy describes the menace that exists in Canada to-day in regard to the illegal traffic in narcotics. It gives actual facts from many Canadian cities and shows how the hypodermic needle is an even greater evil to combat than the opium pipe. The second of these articles will likely be in the July 15th issue.

Is Bootlegging a Passing Phase?

How common is bootlegging in Canada today? How do the members of the bootlegging profession carry on their business and what is their relationship to the officers of the law? These are two of the questions which are answered by A. Innes MacKenzie in a very colorful article describing the adventures, the fortunes and humorous rencontres of Canadian bootleggers from the Atlantic to the Pacific. Mr. MacKenzie writes whereof he knows, as he has spent several months studying this question and even associatting with many of the bootleggers themselves, in the interests of the readers of MACLEAN'S MAGAZINE.

Other Features in the

JUNE 15th MACLEAN'S

What Will Radio Do to Us?
by J. L. Rutledge.

What Shall I Do With My B.A.?
by G. E. S. Pringle.

Babs and the Manager
by Leslie Gordon Barnard.

The Golden Fleece
A long "short" story
by Bertrand W. Sinclair.

A Ruthenian Wedding
by Clara Ward.

Barnstorming on the Chautauqua
by Agnes C. Laut.

The Valley of Bleached Bones
by Madge MacBeth.

Ovington's Bank
An intensely interesting serial
by Stanley J. Weyman.

Is the Canadian Flapper a Menace?

This is a question raised by Mrs. Gertrude S. Pringle in a startling article dealing with conditions as they too frequently exist in some Canadian centres. Extraordinary conditions are described by Mrs. Pringle, who is a thorough and conservative investigator. It is only too true, evidence regretfully shows, that some Canadian flappers are very much akin to their American sister who "parks her corsets and indulges in petting parties."

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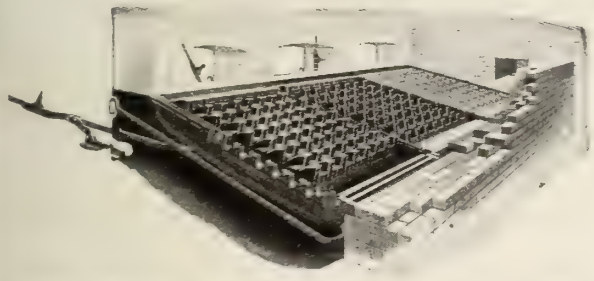

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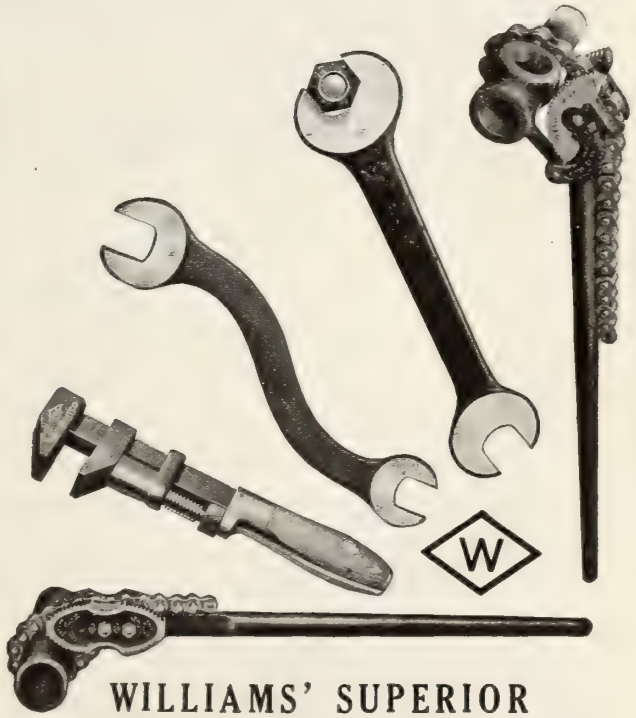

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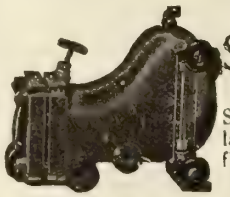

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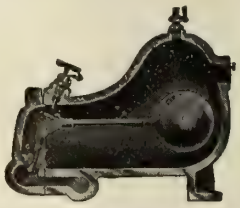

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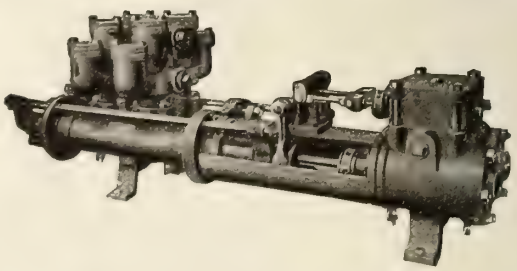

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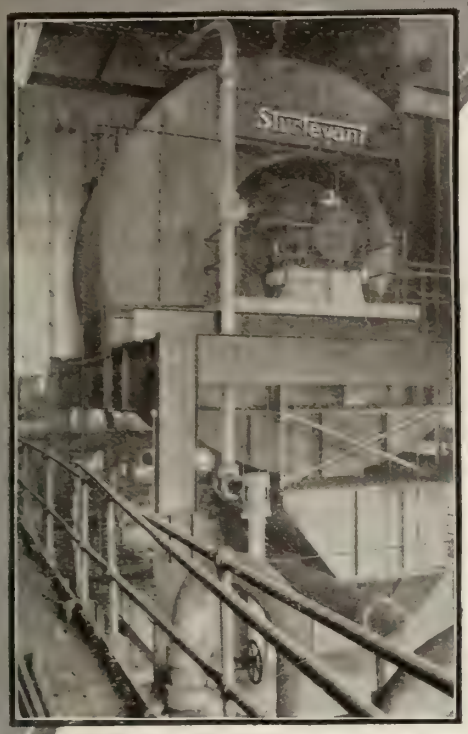

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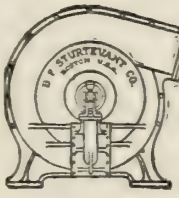

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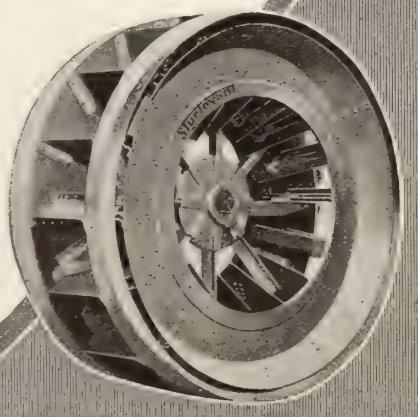

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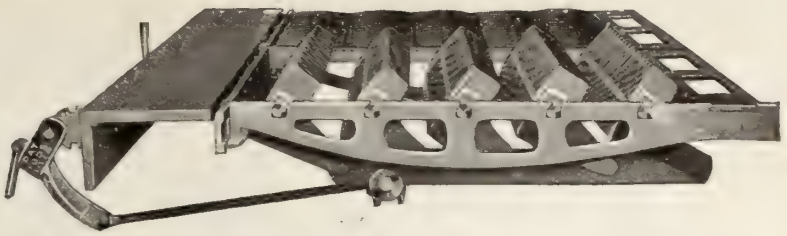

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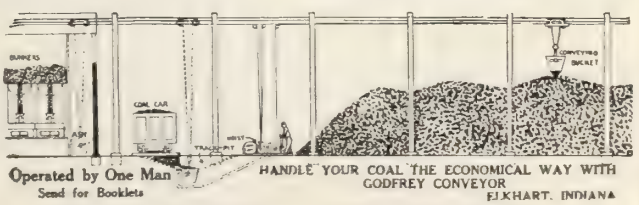

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124-147 Thirteenth St. - Elkhart, Indiana, U.S.A.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N. Y.

CLEANERS, BOILER TUBE CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.
Canadian Johns-Manville Co. Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison Co., Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West Toronto.
MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CARBONIC ACID GAS
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, ue.
MacGovern & Co., Inc., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co. Ltd., Toronto.

CONDENSATION RECEIVER
The Mason Regulator & Eng., Co., Ltd., Montreal.

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal.
Mackinnon Steel Co., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Mead-Morrison Mfg. Co., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co. Ltd., Montreal

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach., Co. Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Babcock Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox Ltd.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaffer & Budenburg Mfg. Co., Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRILL RODS
Lincoln Electric Co., of Can. Ltd., Toronto

DROP- FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg., Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, ue
MacGovern & Co., Inc., New York

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.
B. F. Sturtevant Co., Boston, Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
MacKinnon Steel Co., Ltd., Sherbroke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Pelt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co., of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg., Co., Toronto.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Prantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F. Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N.Y.

EYE BOLTS

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The Montreal.
Sturtevant Co., B. F. Toronto, Can.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montrea
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont
Pratt & Cady Co., Inc., Hartford, Conn
Robb Engineering Works, Ltd., Montrea
MacGovern & Co., Inc., Montreal, Que
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co., Montreal, Que.

FEED WATER PURIFIERS
Grover Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

FILTERS
Grover Corp., East Chicago, Ind.
S. F. Bowser Co., Ltd., Toronto., Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Grover Corp., East Chicago, Ind.
MacKinnon Steel Co., Ltd., Sherbrooke.
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittsburgh, Pa
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATION SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Grover Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal .
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYRDAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane Limited, Montreal.

FITTINGS, CAST IRON
Crane Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont
Jefferson Union Co., Lexington, Mass
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

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Allen Engines	South Bend Lathes
Landis Threaders	Dick's Balata Belting
Graton & Knight Leather Belting	Norton Grinding Wheels
Yale Chain Hoists	Fairbanks-Morse Generators
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Hamilton Windsor Winnipeg Regina
Saskatoon Calgary Vancouver Victoria

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Crane's Limited Montreal

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co. Ltd., Toronto

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co.
Canadian Flow Meter Co., Toronto
Mason Regulator & Engineering Co., Ltd., Montreal
National Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Metaer Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

FLUE CLEANERS
Shell Bar Boico Supply, Ltd., Toronto.
Bremner & Wilson Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Penn Packing & Fire Brush Mfg Co., St. Louis, Mo

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke.
Wm B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.
S. F. Bowser Co., Ltd., Toronto, Ont.

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Canadian Johns-Manville Co. Ltd., Toronto
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto
Dominion Flow Meter Co., Toronto

GAS METERS
Bailey Meter Co.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Feltham Asbestos (Canada) Co., Toronto.
Canadian Johns-Manville Co. Ltd. Toronto
Penberthy Mfg. Co., Toronto
Penn Packing & Fire Brush Co., New York, N.Y.
Garlock Packing Co., Franklin Co., Pa
Garlock Packing Co Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto
Penn Packing & Fire Brush Co., New York, N.Y.

GAS ANALYSIS CO-2
Dominion Flow Meter Co., Toronto

GAS PRODUCER PLANTS
Can. Fairbanks-Morse Co., Ltd., Montreal

GASOLINE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

GAUGE COCKS
Mason Regulator & Eng. Co., Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGE COCKS, STANDARDS AND EXTRA HEAVY
Jas Morrison Brass Mfg Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio

Penberthy Injector Co., Windsor, Ont.

HANGES, GAUGES, AMMONIA, OIL, GAS, AIR
Mason Regulator & Eng., Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

GAUGES, DRAFT
Sanford Riley Stoker Co., Worcester, Mass
Taylor Instrument Co., Toronto, Ont.
Arthur S. Leitch Co., Ltd., Toronto.

GAUGE GLASSES
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Column Co., The, Cleveland, Ohio
Schaffer & Budenberg Mfg. Co., Brooklyn, N.Y.
John Moncreiff, Perth, Scotland.
W. J. Wall, Montreal.

GAUGE, RECORDING
Jas. Morrison Brass Mfg. Co., Toronto
Taylor Instrument Co., Toronto, Ont.

GAUGES, PRESSURE, VACUUM DRAFT AND RECORDING, AND MICROMETER
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y.

GAUGES, WATER
Babcock & Wilcox, Ltd., Montreal.
Jenkines Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
as. Morrison Brass Mfg., Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Bovin Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Smart-Turner Co., Ltd., Hamilton.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

GENERATORS AND CONVERTERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

GOVERNORS, ENGINE
Waterous Engine Works Co., Brantford.
Mason Regulator & Eng., Co., Ltd., Montreal, Que.
Smart-Turner Machine Co., Ltd., Hamilton
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

GRAB BUCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

GRATES, DUMPING, ROCKING, STATIONARY, SHAKING
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Penock, Reg'd, Montreal.
Canadian Steam Boiler and Equipment Co., Toronto.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto, Ont.

GRATE BARS, FURNACE
Canadian Steam Boiler & Equipment Co., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Shell Bar Boico Supply Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
Shell Bar Boico Supply Co. Ltd., Montreal
W. R. Sexton Boiler Setting Co., Toronto
R. C. Miller Oil & Supply Co., Ltd., Montreal.

GREASE AND OIL EXTRACTORS
Mason Regulator & Eng., Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg., Co.
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal

HAND PUMPS, OIL AND GASOLINE
S. F. Bowser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.
Graver Corp., East Chicago, Ind.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

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Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Graver Corp., East Chicago, Ind.
B. F. Sturtevant Co., Boston, Mass.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Pelt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co., Ltd., Toronto.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

HOSE, STEAM, SUCTION AND WATER
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.

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Arthur S. Leitch Co., Ltd., Toronto.
Graver Corp., East Chicago, Ind.
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Pratt & Cady Co., Inc., Hartford, Conn.

HYDRANTS
Dominion Steel Products Co., Ltd., Brantford, Ont.
Kerr Engine Co., Walkerville, Ont.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd. Lindsay, Ont.
Frick Co., Waynesboro, Franklin C.o, Pa.
MacGovern & Co., Inc., Montreal, Que.

ICE AND REFRIGERATION EQUIPMENT
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Jamieson Cold Storage Door Co., Hagerstown, Md.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, STEAM AND GAS ENGINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
Taylor Instrument Co., Toronto, Ont.
Yarnall-Warig Co., Philadelphia, Pa.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The Hartford, Conn.

INSULATORS
Johns-Pratt Co., The Hartford, Conn.

IRON FILLER
Can. Johns-Manville Co. Ltd., Toronto.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

LACE LEATHERS
Can. Johns-Manville Co., Ltd., Toronto.
R. C. Miller Oil & Supply Co. Ltd., Montreal.
D. K. MacLaren Ltd., Montreal, Que.

LAMPS, ARC
Can. Fairbanks-Morse Co., Ltd. Montreal
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

J. H. Williams & Co., Brooklyn, N.Y

LAMPS, INCANDESCENT
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Johns-Manville Co., Ltd. Toronto, Ont.

LEATHER FILLET
D. K. McLaren Ltd., Montreal. Que.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.,

LUBRICATORS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATING OIL, FILTERING AND CIRCULATING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

LUBRICATING OIL STORAGE TANKS AND PUMPS
S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
Penberthy Injector Co., Windsor, Ont.
Armstrong Cork & Insulation Co., Mo.

MACHINERY TRANSMISSION (POWER)
Can. Mead-Morrison Co., Mo.
B. F. Sturtevant Co., Boston, Mass.

MARINE CASTINGS
Mueller Mfg., Ltd., The.

MATERIALS, HANDLING PLANTS
Can. Mead-Morrison Co., Montreal.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Arthur S. Leitch Co., Ltd., Toronto.
Murhy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass
MacLean Underfeed Stoker Co., Toronto.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

METERS
The Bailey Meter Co., Cleveland.
Can. H. W. Johns-Manville Co., Toronto.

METERS, (OIL KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto.

MILL AND MINING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

MIXING VALVES
Crane's Limited, Montreal.

MOTORS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd. Montreal.
Lincoln Electric Co. of Can. Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

OILS
Imperial Oil, Ltd., Toronto.
E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL SEPARATORS
V. D. Anderson, Cleveland, Ohio.
The Mason Regulator & Eng. Co., Ltd.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto

Pumping By Electricity

INCLUDED in the equipment of the Hamilton, Ont., pumping plant is the electric motor driven pump shown herewith. This pump delivers 8,350 gal. per min. against 300 ft. head when running at 750 r.p.m., and is driven by a synchronous induction motor.

The low starting torque, high efficiency and power-limiting characteristic of the De Laval centrifugal pump are highly favorable to electric motor drive. In the present case, the motor starts as an induction motor, and then by switching on a direct current exciter, to be seen on the end of the shaft, the motor synchronizes itself and continues to run as a synchronous machine. In this way the unit is not only self starting, but may also be used to overcome the effects of induction motors on the same line and improve the power factor.

Both parts of the pumping unit are simple in construction and require practically no attention. De Laval centrifugal pumps are made to limit gages on an interchangeable basis. The labyrinth type of wearing ring insures the maintenance of high efficiency over long periods. The wearing ring and impeller are of bronze, as also are the shaft protecting sleeves. Any of these parts can be inserted by ordinary workmen.

State requirements, and our Engineering Department will supply estimates and guarantees.

De Laval
Steam Turbine Co.

Turbine Equipment Co., Limited, 73 King Street West, Toronto
The E. Laurie Company, 243 Bleury Street, Montreal
Taylor Engineering Co., Limited, Vancouver

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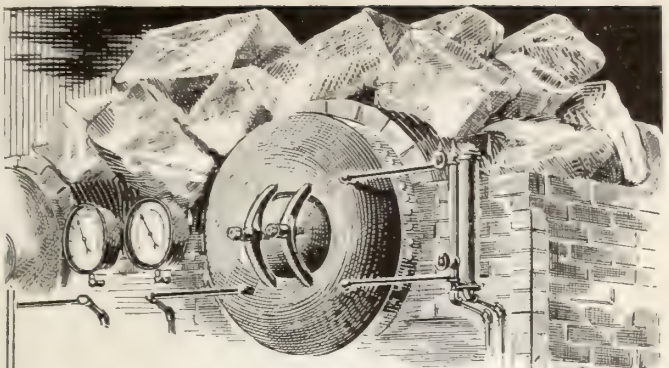


Keep Your Boiler Packed with Ice

By packing ice around your boiler you will reduce the temperature. This makes it more difficult to keep steam up. More coal will be required. Your fuel bills will be higher.

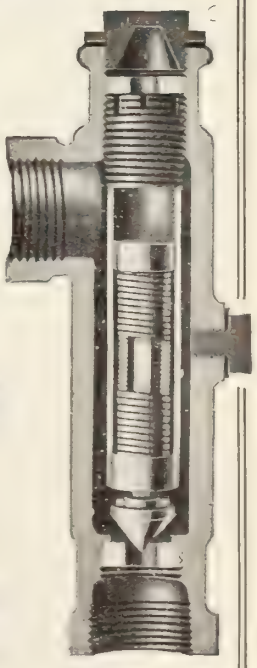
Ridiculous? Of course it is! But not any more ridiculous than the practice of trapping steam lines a hundred feet or more from the point where steam is used. Every foot of pipe that contains condensate is a foot of pipe that cools steam off and wastes coal! Get rid of the condensate where it forms, instead of at distant points, and cut down this waste! It requires more traps to do this, but the cost is comparatively light when your lines are fitted with the low-priced

STEAM TRAP SARCO

You can buy three Sarcos for the price of one bucket type trap, and by placing them where the condensate forms, you can draw it off instantly, instead of allowing it to drain back through enormous lengths of pipe, chilling the live steam in its progress.

Despite its small size, the Sarco is a little giant for performance. It drains the condensate off as rapidly as it forms, returning it instantly to the hot well without loss of heat units.

Many engineers have marvelled at the simple but scientific construction of the Sarco—the highly sensitive thermal element—the absence of complicated parts.



A 30 Days' Free Trial

will prove to you that the Steam Trap Sarco is a money saver. Quickly installed, does not require pit- heading or platform-building. Made in sizes ⅜ in. to 3 in., for any given presure up to 200 lbs.

Write today for Booklet No. J. 26 and full particulars about Free Trial Offer.

SARCO COMPANY, INC.
239 Broadway, New York City
BUFFALO CHICAGO CLEVELAND
DETROIT PHILADELPHIA

Peacock Bros. Limited, Montreal

OIL STORAGE AND DISTRIBUTING SYSTEMS

Jas. Morrison Brass Mfg Co., Toronto
S. F. Bowser Co., Ltd., Toronto., Ont

OILING SYSTEMS

S. F. Bowser Co., Ltd., Toronto., Ont.
[illegible] Co. Cincinnati, Ohio

PACKING, AMMONIA, STEAM AND WATER

Feldam Asbestos Canada Co., Toronto.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Ltd., Montreal.
Crane Packing Co., Chicago Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesoarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York
Shell Bar Boico Supply Ltd., Toronto.

PACKING, METALLIC

Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
S. F. Bowser Co., Ltd., Toronto, Ont

PACKING, OIL

Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PAINTS

Shell Bar Boico Supply Ltd., Toronto, Ont

PENSTOCKS

Boving Hydraulic & Eng. Co., Ltd, Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que
Wm. B. Scfiae & Sons, Pittsburgh, Pa

PIPE COILS

Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE

The Superheater Co., Limited, Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER

Armstrong Cork & Insulation Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto

PIPE, BLACK AND GALVANIZED

Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont

PIPE, SOIL, AND FITTINGS

Crane's Limited, Montreal

PIPE STEEL

Boving Hydr & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont

PIPES, WATER

Boving Hydr & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont

PIPE JOINT COMPOUNDS

Crane's Limited, Montreal.

PIPING AND FITTINGS

Crane Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio
York Manufacturing Co., York, Pa.

PIPING, STEAM

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt
Page-Hersey Tubes, Ltd., Toronto, Ont

PLATE WORK

Goldie & [illegible]
MacKinnon Steel Co., Ltd., Sherbrooke
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford

PLUG COCKS

Hancock Valve Mfg. Co., Pittsburgh.
Lunkenheimer Co., Cincinnati, Ohio

PLUMBING SUPPLIES

Jas. Morrison Brass Mfg. Co., Toronto

POWER HOUSE CONVEYORS

Can. Link-Belt Co., Toronto, Ont.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt
MacCarren & Co., Inc., Montreal
MacCarren & Co., New York
Waterous Engine Works Co., Brantford

POWER PUMPS (OIL, GASOLINE)

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Fisher Governor Co., Marshalltown, Iowa

PRESSES

Boving Hydr. & Engine Co., Ltd.
Toronto

PRESSURE REGULATORS

The Fisher Governor Co. (Inc.), Marshalltown, Iowa
Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES

Toronto Brass Mfg. Co., Ltd.

PRESSES, HYDRAULIC

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frankfort Co., Pa.

PRESSURE AND REDUCING VALVES

Toronto Brass Mfg. Co. of Canada, Ltd.
Toronto, Ont.

PULLEYS, WOOD AND STEEL

D. K. McLaren Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullough Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH

Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY

The Mason Regulator & Eng. Co., Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch, Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL

Boving Hydr. &Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montrela, Que.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS

Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, AIR

American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID

Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, ue.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, BILGE

Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE) CURB

S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL

American Steam Pump Co., Battle Creek.
Boving Hydr & Eng. Co., Ltd, Lindsay
Goldie & McCulloch Co, Galt
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Waterous Engine Works [illegible]

PUMPS, CIRCULATION

Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal

PUMPS, DUPLEX

The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL

American Steam Pump Co., Battle Creek.
Laurie & Lamb, Montreal
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady Hartford Conn.

PUMPS, FEED WATER

Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montrea
Pratt & Cady, Hartford, Conn.

PUMPS, GAS

Smart-Turner Machine Co., Hamilton.

PUMP GOVERNORS AND REGULATORS

Mason Reg. & Eng. Co., Ltd., Montreal.
The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HAND AND POWER

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co. (Inc.) Marshalltown, Iowa

PUMPS, GEARED, COMPOUND

American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.

PUMPS, HYDRAULIC, PRESSURE

Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Llindsay.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Samrt-Turner Machine Co., Hamilton.

PUMPS, OIL

American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER

American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO

Mason Reg. & Eng. Co., Ltd., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Tornto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX

Pratt &Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM

American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING

S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER

Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS

Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS

Crane's Limited, Montreal.

RADIATOR TRAPS

Sarco Co., The New York, N. Y.

RADIATOR AIR VENTS

Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES

Lunkenheimer Co., Cincinnati, Ohio.

RAGS

Shell Bar Boico Supply Ltd., Tornto.

RAILWAY OIL STORAGE AND HANDLING SYSTEMS

S. F. Bowser Company, Ltd., Toronto.

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Frick Co., Waynesboro, Sranklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.
MacKinnon, Holmes & Co., Sherbrooke.

RECEIVERS, AIR

MacKinnon, Holmes & Co., Sherbrooke

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S. F. Bowser Company Ltd., Toronto.

RECORDING INSTRUMENTS

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bailey Meter Co., Cleveland.
Canadian Johns-Manville Co., Ltd., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS CO-2

Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES

American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Schaeffer & Budenburg Mfg. Co., Brooklyn, N. Y.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.

Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY,

Boving Hydr. & Eng. Co., Ltd., Lindsay,
Canadian Planet Engineerin Co., Ltd., Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE

Laurie & Lamb, Montreal.

REGISTERING MEASURES

S. F. Bowser, Company, Ltd., Toront.o

REGULATORS, DAMPER

Mason Reg. & Eng. Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto
Taylor Instrument Co., Toronto, Ont

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Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co. Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS

The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERAAURE

Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Toronto, Ont.

REGULATING VALVES

Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

RETORTS

MacKinnon Steel Co., Sherbrooke Que.

REVOLVING DOORS FOR HARDENING ROOMS

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ROLLS, CRUSHING

Can. Link-Belt Co., Toronto, Ont.

RUBBER CEMENT TANKS AND PUMPS

S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES

Can. LinkBelt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER

Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Torotno.
R. C. Miller Oil & Supply Co., Itd., Montreal.

SAW MILL CONVEYORS

Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY

Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS

Babcock & Wilcox Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SCREWED, FLANGED AND MALLEABLE SCREWED

Cranes' Limited, Montreal.

SEPARATORS, STEAM

V. D. Anderson, Cleveland, Ohio.
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N. Y.
D'Este Co., uJlian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAKING BARS ARCHES, ETC.

Sanford Riley Stoker Co., Worcester, Mass.

SHAFTING

Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS

W. R. Sexton Boiler Setting Co., Toronto.

EXPANSION ENGINES SINGLE, COMPOUND & TRIPLE

Laurie & Lamb, Montreal.

SMOKE BOXES

Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOAP, SOFT

R. C. Miller Oil & Supply Co., Ltd., Montreal.

SOAP, POWDER

R. C. Miller Oil & Supply Co., Ltd., Montreal.

SOOT BLOWERS

Canadian Planet Engineering Co., Ltd., Windsor, Ont.

SOOT CLEANERS

Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

SPECIAL MACHINERY

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS

Can. Link-Belt Co., Tornto, Ont.

SPRAY WATER COOLING SYSTEMS

Arthur S. Leitch Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS

Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

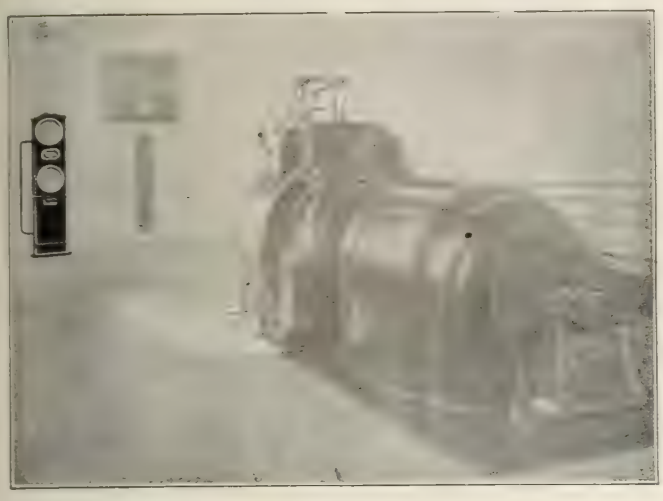
SPUR WHEELS

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL

Babcock & Wilcox, Ltd., Montreal.

THE VENTURI METER GROWS WITH THE PLANT



Turbine Room, D. Goff & Son, Pawtucket, R. I.

When new boilers are added to the power plant old auxiliaries often have to be scrapped and new ones purchased. Not so with the Venturi Meters.

The measuring capacity of a Venturi is easily changed, at slight expense, by substituting a new throat section in the Meter Tube and new dials in the Register-Indicator-Recorder. Some Venturi Meters have been altered several times during their long term of service without impairing their accuracy to the slightest extent.

The Venturi Meter is used to measure boiler feed water, steam, condensation from heating systems, circulating water to condensers, etc., in the modern power plant. It is accurate, durable and positive; behind it is an enviable record of 30 years and thousands of successful installations.

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Ottawa Montreal Winnipeg Vancouver

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Toronto, Ontario

PLIBRICO JOINTLESS

FURNACE LINING

PLIBRICO is a plastic refractory. When molded into jointless baffles, side walls, and arches, and properly baked and vitrified, it forms boiler settings that resist heat up to 3,100° F., that are air and gas tight, and that outlast laid-up fire brick many times.

When the first container of PLIBRICO is rolled into a plant, profits increase, for PLIBRICO means a saving of more than 10% on fuel bills; it is a time saver and a labor saver, and it is an insurance against loss from shutdowns for boiler setting repairs.

Get acquainted with PLIBRICO. Our book L-63 on "Modern Furnace Building," gives full information. Yours for the asking.

PLIBRICO is delivered only in steel containers of distinctive appearance, as shown below.

DISTRIBUTORS: Beveridge Supply Co., Ltd., Montreal, Que.; Shell Bar Boico Supply Co., Ltd., Toronto, Ont.; Evans Coleman & Evans, Vancouver, B. C.; Winnipeg Supply & Fuel Co., Winnipeg, Man.; Gorman's Ltd., Calgary, Alta.

POWER PLANT EQUIPMENT

New and Used—

Equipment that shows clearer than words the Petrie policy of quality, service and satisfaction.

Firebox Boilers
12 H.P. to 150 H.P.
Horizontal Boilers
15 H.P. to 200 H.P.
Marine—Internal Fired

Tanks—any size, any capacity

Vertical Boilers
1 H.P. to 75 H.P.

Vertical Engines
2 H.P. to 75 H.P.

Automatic Engines
6 H.P. to 450 H.P.

Horizontal Engines
5 H.P. to 250 H.P.

H. W. Petrie, Ltd.

Toronto and Hamilton

OIL STORAGE AND DISTRIBUTING SYSTEMS
Jas. Morrison Brass Mfg. Co., Tornoto
S. F. Bowser Co., Ltd., Toronto., Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto., Ont.
[illegible] Co., Cincinnati, Ohio

PACKING, AMMONIA, STEAM AND WATER
Peldam Asbestos Canada Co., Toronto.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Ltd., Montreal.
Crane Packing Co., Chicago Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesoarre, Pa
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, METALLIC
Crane Packing Co., Chicago, Ill
Flexible Metallic Packing Co., Windsor, Ont.
S. F. Bowser Co., Ltd., Toronto, Ont

PACKING, OIL
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd. Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que
Wm. B. Scfiae & Sons, Pittsburgh, Pa

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
Mfg. Co., York, Pa.

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Limited, Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal
Can. Johns-Manville Co., Ltd., Toronto.

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE STEEL
Boving Hydr & Eng Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont

PIPES, WATER
Boving Hydr & Eng Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio
York Manufacturing Co., York, Pa

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal
Goldie & McCulloch, Co., Galt
Page-Hersey Tubes, Ltd., Toronto, Ont

PLATE WORK
Goldie & McCulloch Co., Galt, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford

PLUG COCKS
Hayward Valve Mfg Co., Pittsburgh
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POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
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Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt
MacGregor & Co., Inc., Montreal
MacGregor & Co., New York
Waterous Engine Works Co., Brantford

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S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

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Boving Hydr. & Engine Co., Ltd., Lindsay.

PRESSURE REGULATORS
The Fisher Governor Co., (Inc.), Marshalltown, Iowa.
Taylor Instrument Co., Toronto, Ont.

PRESSURE AND VACUUM RELIEF VALVES
[illegible] Co., Ltd.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frankin Co., Pa

PRESSURE AND REDUCING VALVES
Toronto, Ont.

PULLEYS, WOOD AND STEEL
D. K. McLaren Ltd., Montreal, Que.
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Can. Fairbanks-Morse Co., Montreal.
Goldie & McCullough Co., Galt.
Waterous Engine Works Co., Brantford.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
Poving Hydr. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
Arthur S. Leitch, Co., Ltd., Toronto.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
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Darling Brothers, Ltd., Montrela, Que.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, ACID
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, ue.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, BILGE
Laurie & Lamb, Montreal.
Smart Turner Co., Hamilton, Ont.

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE) CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd, Lindsay
Goldie & McCulloch Co, Galt
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart, Turner Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford

PUMPS, CIRCULATION
Smart Turner Co., Hamilton, Ont.
Laurie & Lamb, Montreal

PUMPS, DUPLEX
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Laurie & Lamb, Montreal
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Smart-Turner Machine Co., Hamilton.

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The John H. McGowan & Co., Cincinnati Ohio.
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co. (Inc.) Marshalltown, Iowa.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can Fairbanks-Morse Co., Ltd., Montreal.

PUMPS, HYDRAULIC, PRESSURE
Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Llindsay.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Samrt-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Tornto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX
Pratt &Cady, Stratford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

PUMP TANK, RECEIVER
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
The John H. McGowan & Co., Cincinnati, Ohio.
Smart-Turner Machine Co., Hamilton.

PYROMETERS
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

RADIATORS
Crane's Limited, Montreal.

RADIATOR TRAPS
Sarco Co., The New York, N. Y.

RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

RADIATOR VALVES
Lunkenheimer Co., Cincinnati, Ohio.

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Shell Bar Boico Supply Ltd., Tornto.

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S. F. Bowser Company, Ltd., Toronto.

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Frick Co., Waynesboro, Sranklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.
MacKinnon, Holmes & Co., Sherbrooke.

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MacKinnon Holmes & Co., Sherbrooke

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Bailey Meter Co., Cleveland.
Canadian Johns-Manville Co., Ltd., Toronto.
Taylor Instrument Co., Toronto, Ont.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS CO-2
Sarco Company, Inc., New York.

RECORDING THERMOMETER AND GAUGES
American Steam Gauge & Valve Mfg. Co. Boston, Mass.
Schaeffer & Budenburg Mfg. Co., Brooklyn, N. Y.
Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY,
Boving Hydr. & Eng. Co., Ltd., Lindsay,
Canadian Planet Engineerin Co., Ltd., Windsor, Ont.
Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.
Smart-Turner Machine Co., Hamilton.

REGULATORS, TEMPERATURE
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser, Company, Ltd., Toronto

REGULATORS, DAMPER
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto
Taylor Instrument Co., Toronto, Ont

REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co. Ltd., Montreal.
Northern Equipment Co., Erie, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Toronto, Ont.

REFRIGERATING PIPE COILS
The Superheater Co., Ltd., Montreal.

REGULATORS, TEMPERAAURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Toronto, Ont.

REGULATING VALVES
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

RETORTS
MacKinnon Steel Co., Sherbrooke Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Toronto, Ont.

ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. LinkBelt Co., Toronto, Ont.

ROOFING, PLASTIC, LIQUID RUBBER
Beveridge Supply Co., Montreal.
Beldam Asbestos (Canada) Co., Torotno.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Cranes' Limited, Montreal.

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Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Direct Separator Co., Syracuse, N. Y.
D'Este Co., uJlian, Boston, Mass.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAKING BARS ARCHES, ETC.
Sanford Riley Stoker Co., Worcester, Mass.

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Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto,

EXPANSION ENGINES
SINGLE, COMPOUND & TRIPLE
Laurie & Lamb, Montreal.

SMOKE BOXES
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOAP, SOFT
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SOAP, POWDER
R. C. Miller Oil & Supply Co., Ltd., Montreal.

SOOT BLOWERS
Canadian Planet Engineering Co., Ltd., Windsor, Ont.

SOOT CLEANERS
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Waterous Engine Works Co., Brantford.

SPEED REDUCING GEARS
Can. Link-Belt Co., Tornto, Ont.

SPRAY WATER COOLING SYSTEMS
Arthur S. Leitch Co., Ltd., Toronto.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Waterous Engine Works Co., Brantford.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
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THE VENTURI METER GROWS WITH THE PLANT

Turbine Room, D. Goff & Son, Pawtucket, R. I.

When new boilers are added to the power plant old auxiliaries often have to be scrapped and new ones purchased. Not so with the Venturi Meters.

The measuring capacity of a Venturi is easily changed, at slight expense, by substituting a new throat section in the Meter Tube and new dials in the Register-Indicator-Recorder. Some Venturi Meters have been altered several times during their long term of service without impairing their accuracy to the slightest extent.

The Venturi Meter is used to measure boiler feed water, steam, condensation from heating systems, circulating water to condensers, etc., in the modern power plant. It is accurate, durable and positive; behind it is an enviable record of 30 years and thousands of successful installations.

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Toronto, Ontario

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Vertical Engines
2 H.P. to 75 H.P.

Automatic Engines
6 H.P. to 450 H.P.

Horizontal Engines
5 H.P. to 250 H.P.

H. W. Petrie, Ltd.

Toronto and Hamilton

Goldie & McCulloch Co., Galt.

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MacKinnon Steel Co., Ltd. Sherbrooke.

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Can. Farnsworth Co., Toronto.
Crane's Limited, Montreal.
D'Este Co., Julian, Boston, Mass.
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Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
The Reliance Gauge Column Co., Cleveland, Ohio.
Lunkenheimer Co., Cincinnati, Ohio.
Watson & McDaniel Co., Philadelphia
Yanall-Waring Co., Philadelphia, Pa

STEAM METERS
Bailey Meter Co.

STEAM CALORIMETERS
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STEAM TRAP TOOLS
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STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
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STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
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Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooks, Que.

STOKERS
Canadian Planet Engineering Co., Windsor, Ont.
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd., Montreal.
Green Engineering Co., East Chicago, Ind.
The Underfeed Stoker Co., of Canada, Ltd. Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
The Fisher Governor Co. (Inc.) Marshalltown, Iowa.
Mason Reg. & Eng., Co., Ltd., Montreal.
Barco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATER, MARINE
The Superheater Co., Ltd., Montreal.

SUPERHEATER, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STATIONARY
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, LOCOMOTIVE
Superheater Co., Ltd., The, Montreal.

SUPERHEATER, STEAM SHOVEL
Superheater Co., Ltd., The, Montreal.

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Canadian Johns-Manville Co. Ltd., Toronto

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
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Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Canadian Johns-Manville Co. Ltd., Toronto
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS
Taylor Instrument Co., Toronto, Ont.

TANKS, BLOW-OFF
Mason Reg. & Eng., Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Co., Ltd., Toronto.
Goldie & McCullough Co., Galt.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCullough Co., Galt.
Leonard & Sons, E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works, Brantford.

TANKS, UNDERGROUND STORAGE
S. F. Bowser Company, Ltd., Toronto.

TANKS, WATER
Mason Reg. & Eng. Co., Ltd., Montreal.
Goldie & McCullough Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TECHNICAL BOOKS
MacLean Publishing Co., Toronto.

THERMOMETERS, INDICATING AND RECORDING
Schaffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Co., Toronto, Canada.
Uehling Instrument Co., New York, N.Y.

THERMOSTATS
Sarco., Inc, New York, N.Y.

TOOLS, SMALL
J. H. Williams & Co., Brooklyn, N.Y.

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The John H. McGowan & Co., Cincinnati, Ohio

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Can. Fairbanks-Morse Co., Montreal.
MacGovern & Co., Inc., Montreal, Que.
Northern Electric Co., Montreal.

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Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
Anderson Co., V. D., Cleveland, O.
Can. Fairbanks-Morse Co., Montreal.
D'Este Co., Julian, Boston, Mass.
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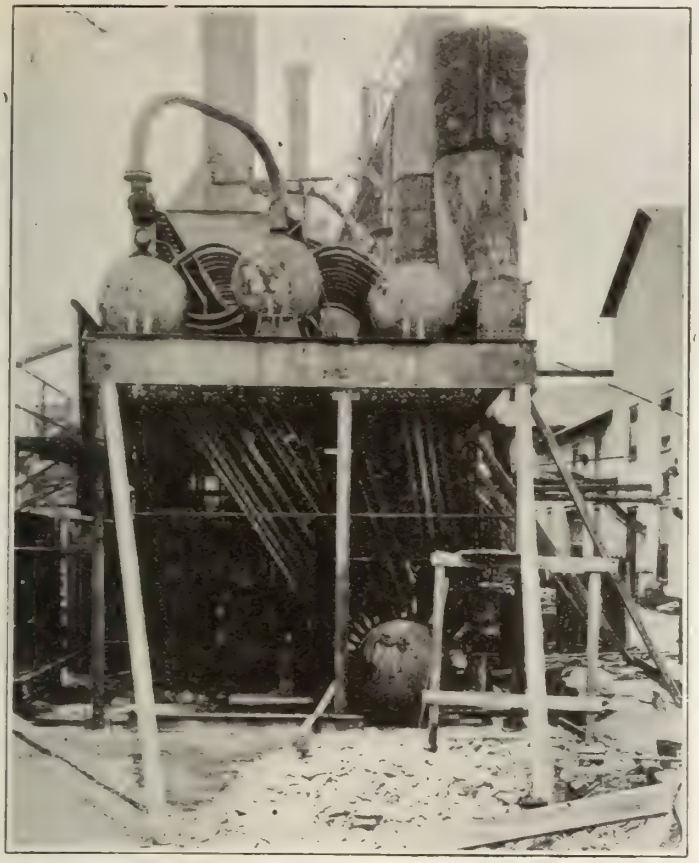

Typical Installation of ELESCO SUPERHEATERS.

Section of **forged return bend** used in ELESCO SUPERHEATERS

ELESCO SUPERHEATERS

The Importance of Design—

A superheater requires as much study from an engineering standpoint as a boiler. Located in a high temperature zone, it must be insured against overheating. As steam must carry away this heat, great care is necessary to determine the correct amount of steam which should flow through the superheater.

In the ELESCO Superheater, high steam velocity is maintained, automatically keeping the inside of the units clean and protecting the heating surface.

The ELESCO Return Bend

Insures a leak proof construction

This return bend is **forged mechanically** on the ends of the units themselves, out of the metal of the unit pipes, without the use of screwed joints and without electrical or acetylene welding. The number of joints to be maintained steam tight is greatly reduced.

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THE SUPERHEATER COMPANY, LIMITED

Transportation Building, Montreal
Works at SHERBROOKE, QUEBEC

WESTERN REPRESENTATIVES:

The Taylor Engr. Co., Ltd., Vancouver, B.C.

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MADE IN CANADA

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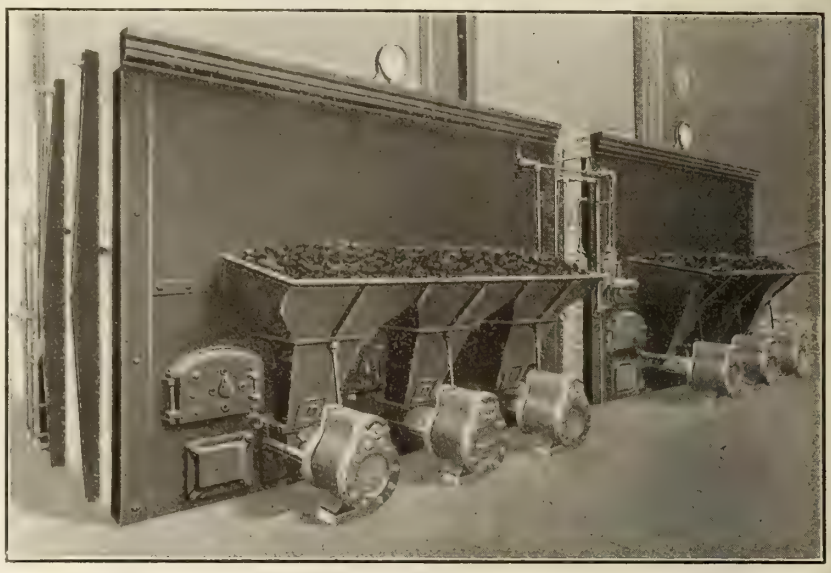
Will Save Coal From The Very First Day!

Wherever the MACLEAN STOKER has been installed the saving in both fuel and labor costs has been sufficient, in a very short time, to pay for the cost of installation.

The MACLEAN STOKER correctly proportions the coal feed and air supply to meet varying demands upon the boilers. These quantities are automatically controlled through the medium of the boiler steam pressure itself. It assures complete combustion and no matter what grade of soft coal is used there is NO SMOKE.



We will gladly give you an estimate of the saving to be made in your plant.

MacLean Underfeed Stoker Company
LIMITED

95-97 KING STREET EAST, TORONTO, CANADA

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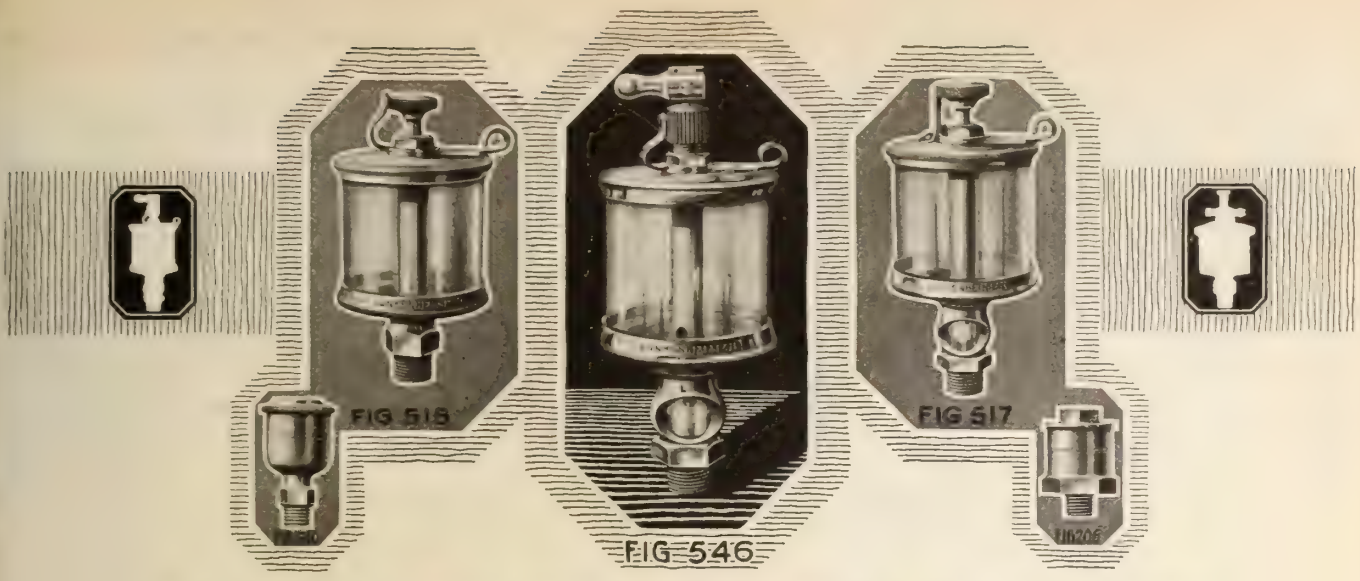

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for Engine and Transmission Bearings

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The highly efficient results which Lunkenheimer Oil and Grease Cups give is but the reflection of close attention to details of design, the use of highest grade materials, accurate machining and the rigid test and inspection which they undergo.

These principles of construction have proved their real worth in service, and that first cost of Lunkenheimer Oil and Grease Cups is an inconsiderable factor as compared with the resultant economy in consumption of lubricant and insured life of equipment.

Modern engineering practice demands a specially designed cup for every purpose and this demand is successfully met by the variety of types and sizes of cups in the Lunkenheimer line.

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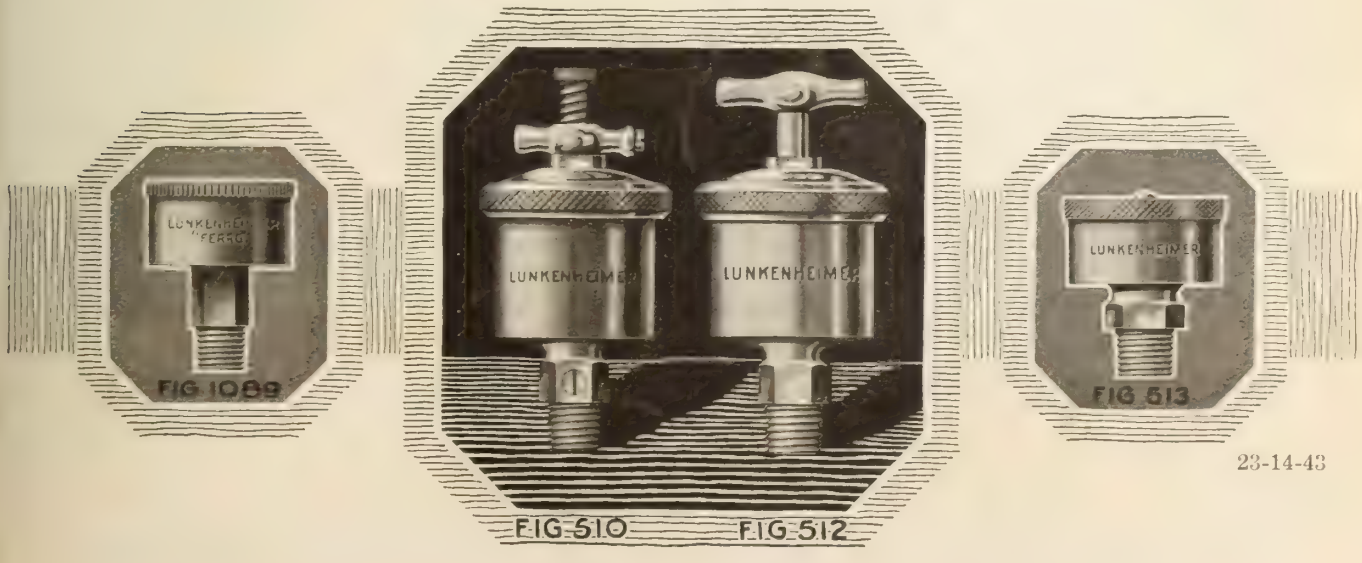

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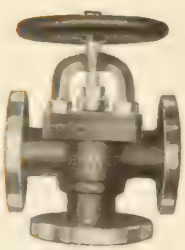
MORRISON

Beaver Valves

Globe Valve



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Check Valve
(Horizontal)

High Pressure Valves

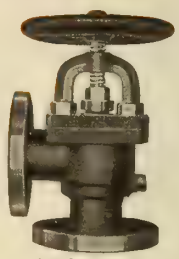
THE increasing use of high pressure steam has created a demand for something better than the ordinary Globe or Angle Valve. Even a heavier valve is not effective, it being a matter of change in design that is required.

"Beaver" Valves were specially constructed to meet this demand and from the very first have been highly satisfactory. They are made in a high-grade bronze in sizes 1-inch to 3-inch, and in iron or semi-steel body with bronze mountings, in sizes 2-inch to 12-inch.

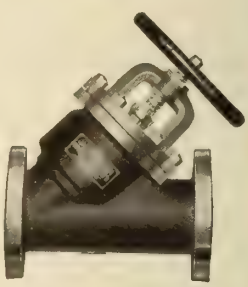
Particular attention is directed to our improved joint between the body and the yoke, the machined faces of the double spigot preventing any possibility of the gasket blowing out. Particularly liberal allowance has been made in the construction of "Beaver" Valves in the areas through the body and seat. There is no cramping anywhere and although the areas are in excess of the nominal diameters of the connecting pipes (permitting a free flow of steam or water) the valves occupy a minimum of space.

"Beaver" Valves are designed for a working steam pressure of 250 lbs. per square inch and are subjected to a hydraulic test of 500 lbs. per square inch before leaving our factory. All parts can be renewed should they become worn or broken.

NOTE—Morrison "Beaver" Valve is the original of this type—all others are imitations. Look for the name "BEAVER."



Angle Valve



Non-Return Stop and
Equalizing "Y" Valve

Check Valve
(Angle)

"Every Installation is a Demonstration of Merit."

The James Morrison Brass Mfg. Co., Limited

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A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

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Strong Where Others Are Weak

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It consists of THE OUTSIDE BONNET CONSTRUCTION. The bonnet **does not** screw **into** the body of the valve, it fastens to it by **outside** threads on the body; consequently, these threads never come in contact with the corrosive action of steam and water. They are **away** from it. The result is, the Valve bonnet and body can always be taken apart without strain or injury. This construction also prevents spreading of bonnet end of body when screwing down the bonnet tight; it makes them SAFE, SURE and STRONG.

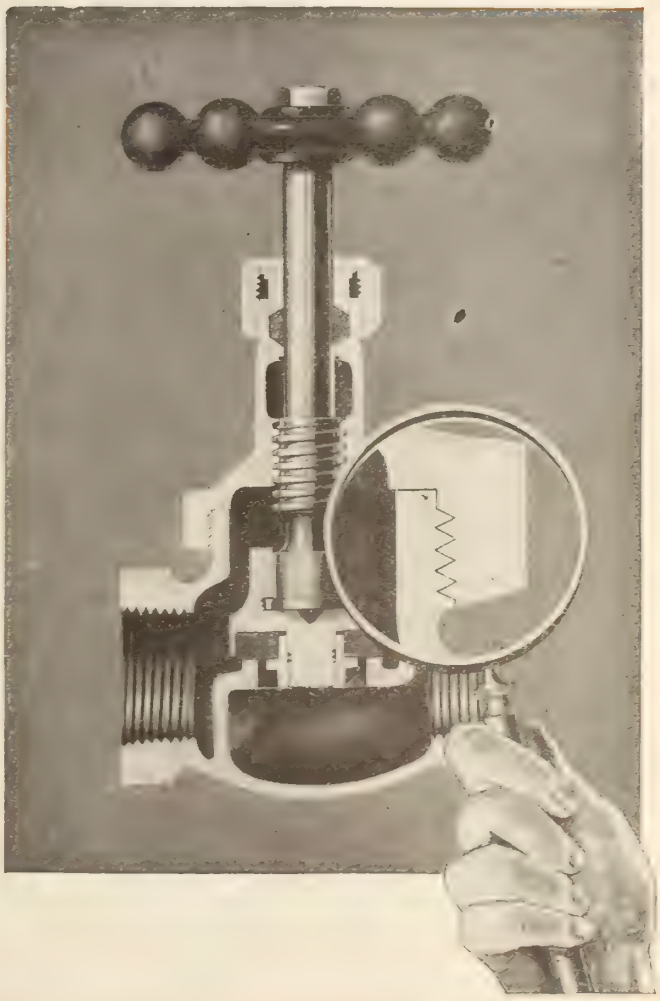

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Fig. 106
Jenkins Brass Globe Valve
(Standard Pattern)

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Each valve is designed with mathematical accuracy assuring correct proportion, providing a stronger valve which will furnish maximum service even under the most severe working conditions.

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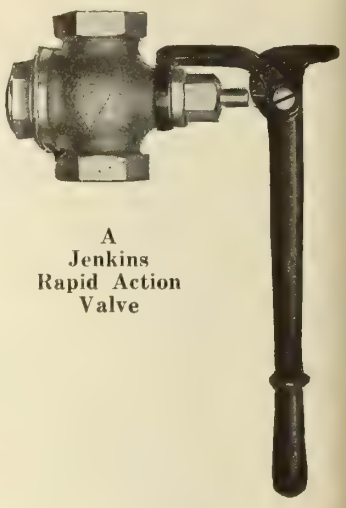

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Rapid Action
Valve

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Files Hand Stokers Getting Results

PANTHER RUBBER COMPANY, LIMITED

GENERAL OFFICES AND FACTORIES
SHERBROOKE, QUE.

SHERBROOKE, CANADA September 23, 1921.

The Waterous Engine Works Co. Ltd.,
Brantford, Ont.

Gentlemen:

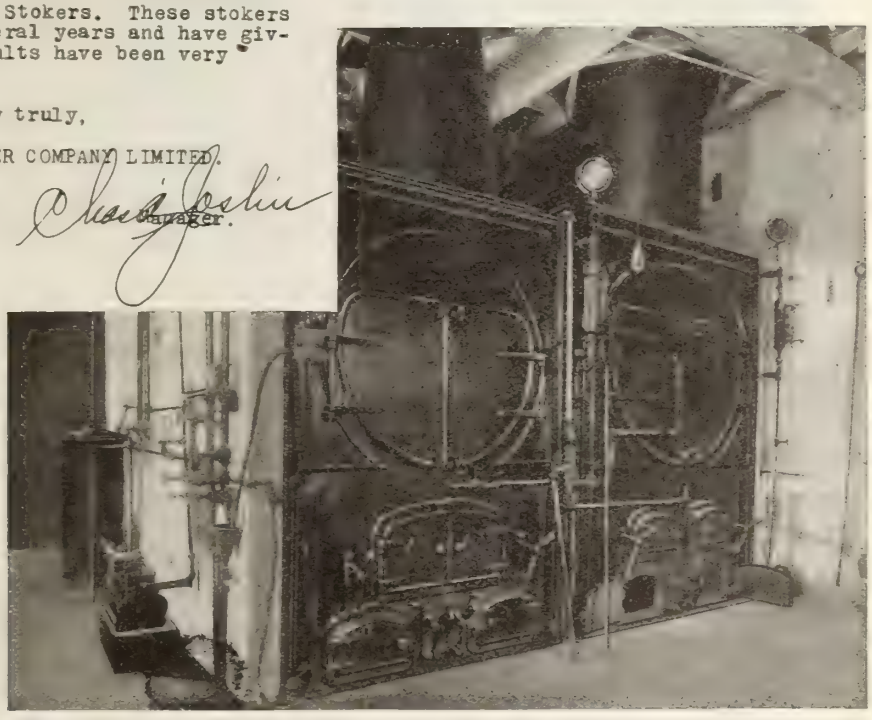
In reply to your letter of the 8th instant we have in our plant the Files Stokers. These stokers have been in operation for several years and have given excellent service. The results have been very satisfactory.

Yours very truly,

PANTHER RUBBER COMPANY LIMITED.

Manager.

CAJ/RMK



It is the uniform excellent service and general satisfaction that have caused progressive men to select **Files Stokers.** These are typical of the more complete data we have compiled:

One installation (3,600 H.P.) saved enough coal to pay for their stoker investment in five months.

A Files installation operated for five months continuously at an average rating of 223%—doubling their steam output.

Files stokers increased efficiency of one plant sufficiently high to warrant discontinuance of two out of eight boilers.

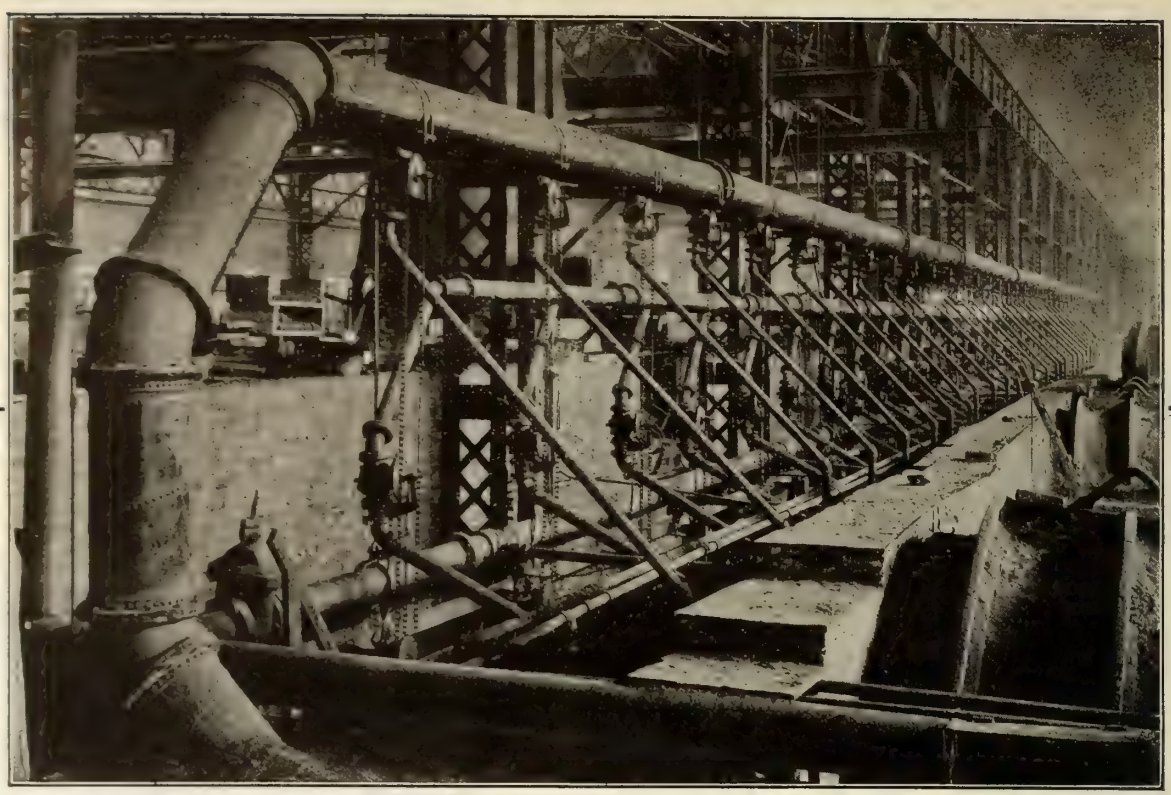
Here is a ready explanation of these achievements:—

1. **Complete volatilization of green coal, causing intensified combustion and smoke dissemination.**
2. **Correct distribution and proper proportion of air according to load carried.**
3. **Fuel bed continuously kept clean, uniform and rich.**

Given the opportunity we will be glad to present these facts for your complete satisfaction.

The Waterous Engine Works Company, Ltd.

Brantford, Ontario



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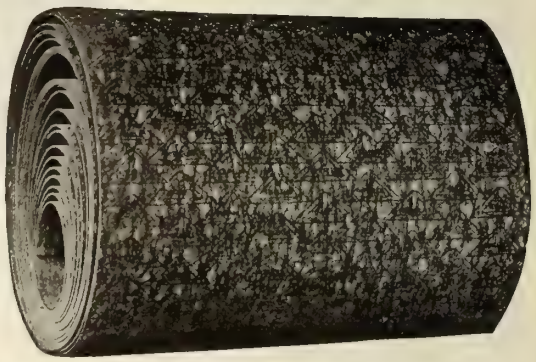

Durabla compressed asbestos fibre sheet packing makes tight joints on steam, water, air, oil, ammonia and acids at all temperatures and pressures. Joints can be broken without injury to gaskets. It will not burn out, blow out, pulp at the joints; requires no following up and is not affected by vibration or condensation. Durabla Packing meets all conditions of shipping and storage.

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GUTTA PERCHA & RUBBER, LIMITED
TRADE P.M.S MARK
TORONTO, CANADA

"P.M.S" BELTING

Built-up Plies of Cotton Duck Woven to our own specifications and firmly united by our Rubber Friction.

We have given special study to this branch of our business with the result that we supply "P.M.S" Belting in fullest confidence that it will meet successfully even the severest tests

For Effective Service in the Transmission Field

Our research has evolved methods that secure maximum adhesion, strength of fibre and age-resisting ability. Careful vulcanization to assure correct, uniform pressure, elimination of surplus elasticity and exactly the right temperature to properly cure the belt without burning the stock is an essential scrupulously maintained.

Our belting experts will be glad to recommend a solution of your problems in belting for all transmissions, conveying of hot or cold materials, bucket elevators, or practically any kind of belt service.

An inquiry involves no obligation.

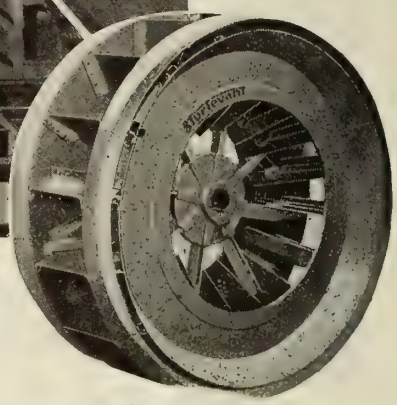
Manufactured Exclusively by

Gutta Percha & Rubber
Limited

Head Offices and Factories, Toronto

Branches in all Leading Canadian Cities

Installation in a Municipal Lighting Plant.



Rotating Member of the Cindervane.

The Cindervane Has Proved Itself

Actual tests showed that four requirements were necessary for catching cinders before they went up the stack to be distributed over the neighborhood. These were

High efficiency in cinder elimination. Reasonable first cost.
Slight reduction in Temperature. Low Power Consumption.

Actual practice shows that the Sturtevant Cindervane possesses all these necessary requirements to a considerable degree. In addition, a highly efficient induced draft is afforded.

It is the only unit made that serves this double purpose. The Cindervane eliminates cinders as satisfactorily as it gives an induced draft.

Every power plant is interested in abating the cinder nuisance. Before discussing your proposition with our engineers we would like you to see a Cindervane under actual working conditions.

Send us your name so that we can forward the address of the installation nearest you.

B. F. STURTEVANT COMPANY OF CANADA, LIMITED

TORONTO GALT MONTREAL

Territorial Representatives :

Empire Engineering & Supply Co., Edmonton, Alta., Kipp Kelly, Ltd., Winnipeg, Man.

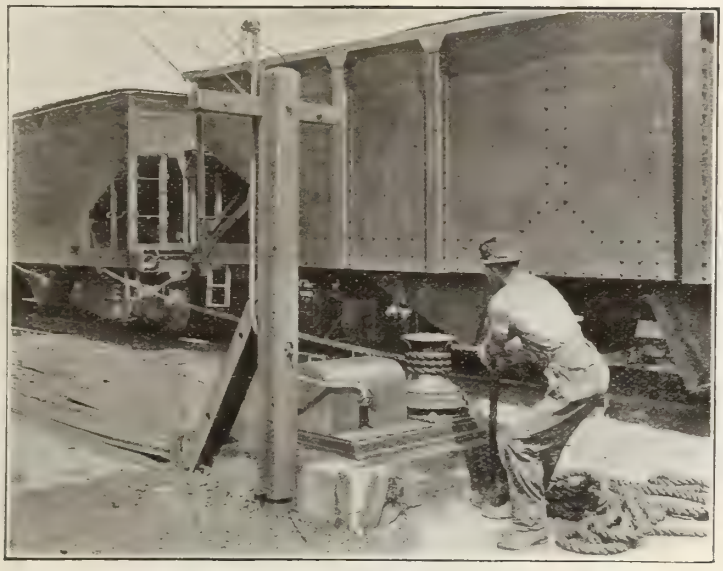
667

"MEAD-MORRISON"

CANADIAN MM ©

CANADIAN MM ©

CAR PULLER



Place your cars with this car puller. Don't wait for the switching locomotive, and don't keep several men on your pay roll—use this car puller instead.

Capstan Type—5 or 7½ H.P.

Drum Type—13, 15, 17, 19 H.P.

All voltages both A.C. and D.C. in stock. A.C. motors for 60 cycle and 25 cycle in stock. Special motors built on order.

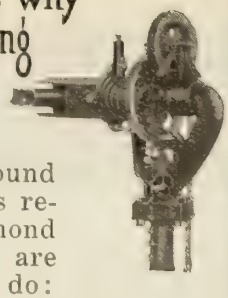
AGENTS:

B.C. EQUIPMENT COMPANY, LIMITED, Vancouver, B.C.
HARVARD, TURNBULL & COMPANY, Toronto, Ont.
POWELL EQUIPMENT CO., LIMITED, Winnipeg, Man.
O'HANLAN, FERGUSON SUPPLY CO., Edmonton, Alta.

MADE IN CANADA BY

CANADIAN MEAD-MORRISON CO
LIMITED
CANADA CEMENT BUILDING
MONTREAL
WORKS: WELLAND ONT.

There are reasons why Central Stations are buying Diamond Valv-in-Head Soot Blowers



The Central Stations have found that the operating economies resulting from the use of Diamond Valv-in-Head soot blowers are tremendous, including as they do:

1 LABOR—a saving of approximately 50 per cent.
2 STEAM—a saving of 40 to 50 per cent. or more.
3. PIPE VALVES and FITTINGS—a saving of 50 to 66 per cent. in cost of pipe, valves and fittings.
4 MAINTENANCE—a reduction in annual charges of 25 to 50 per cent. or more.
5 EFFICIENCY—greater cleanliness of boiler assured.

Among recent Central Station purchasers of 100 units or more may be mentioned:

Commonwealth Edison Company

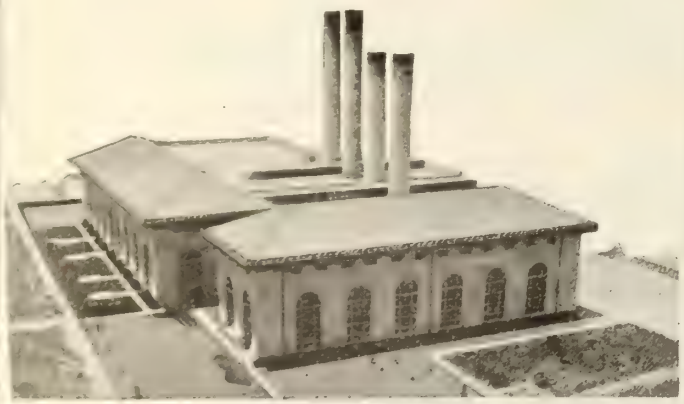
Detroit Edison Company

Penn. Power and Light Company

Within the last few months orders have been received to equip over 125,000 h.p. of Central Station boilers. Diamond Valv-in-Head soot blowers pay big dividends on the investment in them.

If the central stations find that Diamond Valv-in-Head soot blowers save fuel, labor and steam, it is obvious that they can be installed profitably on every high pressure water tube boiler.

Write for Bulletin 287



Diamond Specialty Ltd., Windsor, Ont.

Diamond

VALV-IN-HEAD SOOT BLOWERS

A fact that is commanding greater respect every day—

"THE problem of efficient combustion is primarily one of always regulating both fuel and air supply simultaneously, so that the ratio of air to fuel will always be uniform. After the correct ratio is established, the fuel may burn fast or slow according to the demands for steam, but by modern means of control can be made always to combine in whatever ratio is found to represent best economy."

THIS constantly repeated fact is becoming a law—an axiom of correct combustion. And it is significant that the value of this principle was recognized by the Under-Feed Stoker Company of Canada years ago; automatic control of fuel and air was applied for the first time in the Jones Stoker. An automatic regulating valve is installed on the steam line and this speeds the fan engine and Cole Automatic Valves when the steam pressure tends to drop, likewise slowing them when the pressure starts to fall off. The Cole Automatics increase the speed of the coal ram so that the ideal ratio of fuel is always maintained. An even steam pressure and complete combustion is thus maintained. Eight different points of adjustment are provided, so that the automatic control can be easily set at the point to give best combustion with the particular coal being burned.

As significant as the automatic control of fuel and air are many other vital features. The story of these is told in the Jones "A-C" catalog. Ask for it.

Under-Feed Stoker Co. of Canada, Ltd.
146 King Street West, Toronto

British Columbia: E. A. Earle, Limited, Vancouver, B. C.
Que. and Mar. Prov.: The Cleaton Co., (Canada), Ltd., Montreal, Que.
Alta. and West. Sask.: Mr. J. Twomey, Camrose, Alberta.
Man. and East Sask.: W. W. Hicks & Co., Winnipeg.

Jones "A-C"

Made in Canada—by Canadians
Sold for Canadian money at par

Hand wheel turns easily when packed with 'PALMETTO' twist packing
"PALMETTO" keeps the stem well lubricated
Convenient
Any size valve packed from one spool by unstranding
TRADE
PALMETTO
MARK
Size
Weight 1 Pound
PACKING DOES NOT GET HARD
MANUFACTURED BY
GREENE TWEED & Co.,
109 Duane St.
NEW YORK.
Did you ever wonder why you had to repack the globe valves so often? It's because you use a packing that has no lasting qualities?
TRY
"PALMETTO" Twist Packing
You will find it has the quality that gives long service, and true economy is only found in long service.
Let us send you a sample spool to test —no charge.
GREENE, TWEED & CO.
Sole Manufacturers
109 Duane St. New York
Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.
The real expense of packing a valve is the labor.
The amount of packing used is small.
It's economy to use the packing of long service.

KERR

Dependable Service

DESIGNED and constructed according to the most modern and approved practice, KERR Valves have earned a reputation for dependable service wherever they are installed.

Our forty years' experience, the exercise of the greatest care in design and manufacture, rigid tests before the goods are shipped, and a guarantee by a reliable firm—these are factors that, in many cases, have led to the adoption of KERR Valves as Standard Equipment.

MADE IN CANADA.

The Kerr Engine Co., Ltd.

Valve and Hydrant Manufacturers

Walkerville, Ont.

Feed Your Engine

Dry Hot Steam

Higher efficiency is obtained from the engine when supplied with dry, hot steam than when supplied with steam saturated with moisture.

The **ANDERSON Steam and Oil SEPARATORS**

being scientifically constructed and proportioned, remove the greatest amount of moisture practicable with a separator.

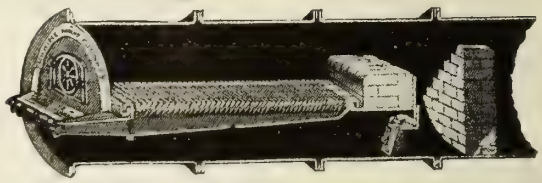
In addition, they are used with marked success for removing oil, water and gasoline from natural gas mains and for removing water and oil from compressed air lines.

Catalogue on request

The V. D. ANDERSON Company

1935 West 96th Street, Cleveland, Ohio

The TURBINE Furnace



Burns Any Fuel

Burns coal slack, coke dust or any low grade fuel with all the advantages of forced draft. Wherever installed it is saving plant owners hundreds of dollars. More than 1,100 giving satisfactory service in British plants.

The Turbine is easy to install and is equally effective for either externally or internally fired boilers.

WRITE FOR FULL PARTICULARS

Manufactured by the Turbine Furnace Co., Limited, London, England.

Sole Canadian Agent:

PERCY A. GOEPEL

525 Pender Street West, Vancouver

Solid wedge disc double seated

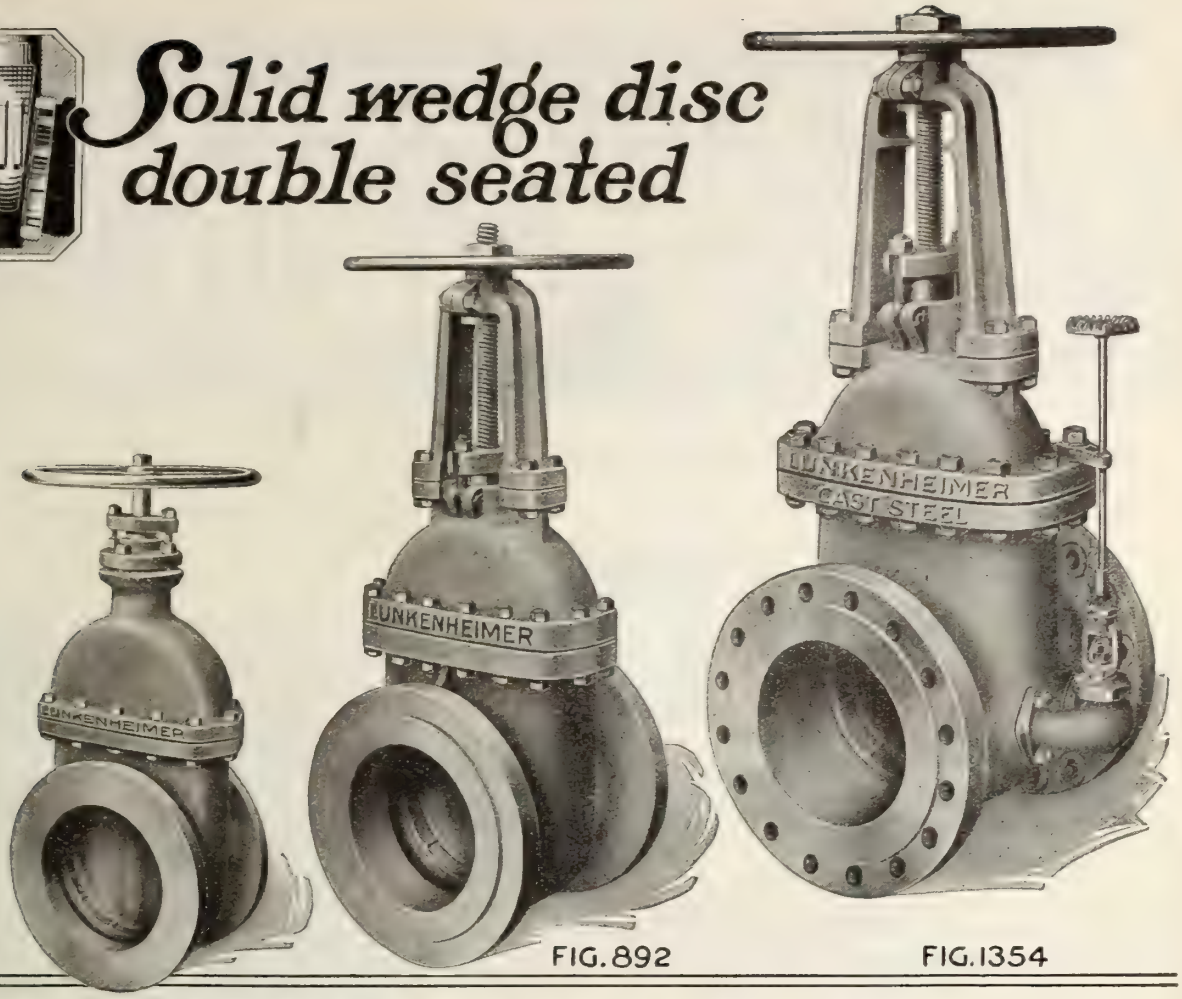


FIG. 648 FIG. 892 FIG. 1354

LUNKENHEIMER *Gate Valves*

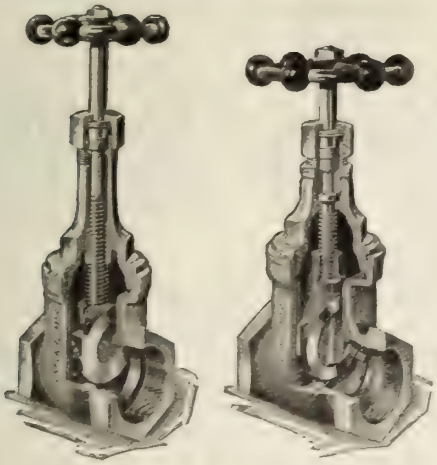


FIG. 427 FIG. 768

are economy valves because they offer more in service and satisfaction per dollar invested. This is the natural result of the Lunkenheimer method of manufacture—incorporating practical design, highest grade materials and sincere workmanship with a system of test and inspection, which guarantees a perfect product of lasting worth.

The broad scope of the line, including valves in every standard size, for all pressures and in material combinations for every purpose, permits of standardization throughout the plant —an added advantage in lowering maintenance costs.

"Lunkenheimer-equipped" is a material aid to efficiency, safety and economy in operation.

Shall we send you descriptive literature?

"America's Best since 1862"

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO CINCINNATI, U.S.A. BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

600-26-43

LINDE

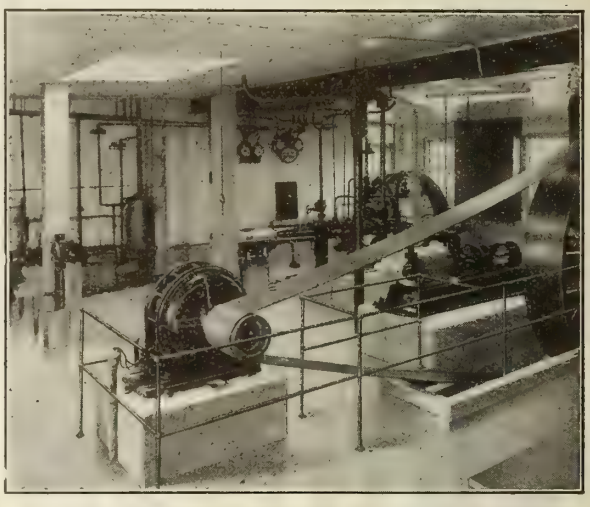
Made in Canada

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

CANADIAN PLANET ENGINEERING COMPANY LIMITED

WINDSOR ONTARIO

Manufacturers of

PLANET MECHANICAL SOOT BLOWERS

Dealers in power plant specialties, mechanical and hand-fired stokers, valves, steam and vacuum traps, gauges and recording instruments, refrigerating machinery.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

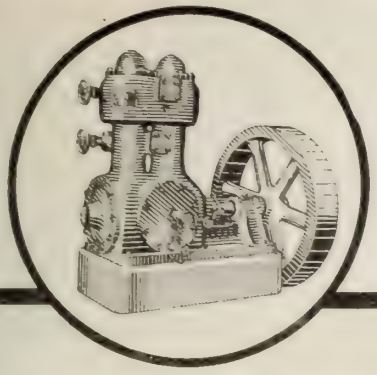
Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. [illegible] Made

The "Unific" does not readily corrode It resists extreme changes of temperature and withstands the highest working steam pressure

JOHN MONCRIEFF LIMITED

PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA



PROMPT SERVICE!

The significant factor when replacements and supplies are needed for Refrigerating Equipment

BRANCH OFFICES AND AGENCIES

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Boston	Winnipeg	Omaha
Brooklyn	Charleston	St. Louis
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Richmond	Detroit	Berkeley
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Erie	Benton Harbor	Fresno
Altoona	St. Paul	Sacramento
Greensburg	Milwaukee	Seattle
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York Service extends beyond the mere creation of excellent products. It is giving our patrons what they want, when they want it and wherever they want it.

York Construction Companies and Agencies are located in 56 of the principal cities of the United States and Canada.

The Construction Companies maintain local Service, Construction and Repair Shops for complete equipment installations. York Products are carried in stock; also supplies including Ammonia, CO_2, Calcium, Oil, Packing, Pipe, Insulating Material, etc.

We will be glad to have you test our facilities for Prompt Service.

YORK MANUFACTURING COMPANY

Ice Making and Refrigerating Machinery Exclusively

YORK, PENNA., U.S.A.

Cold Storage Plants

conserve most of the nation's food, and Refrigerating equipment is the most essential element in their construction.

To hold proper temperatures constantly, install

Frick Refrigerating Machinery and Equipment

Cold Storage Plants - Smallest to Largest

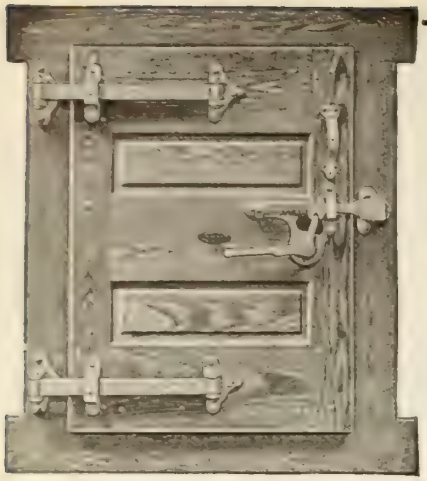
Write for Catalog

Ask for a copy of our List of Users covering 48 pages of satisfied customers — also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose — all types; Vertical — Horizontal — Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal



Jamison

HEAVY DUTY
Cold Storage Doors
Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

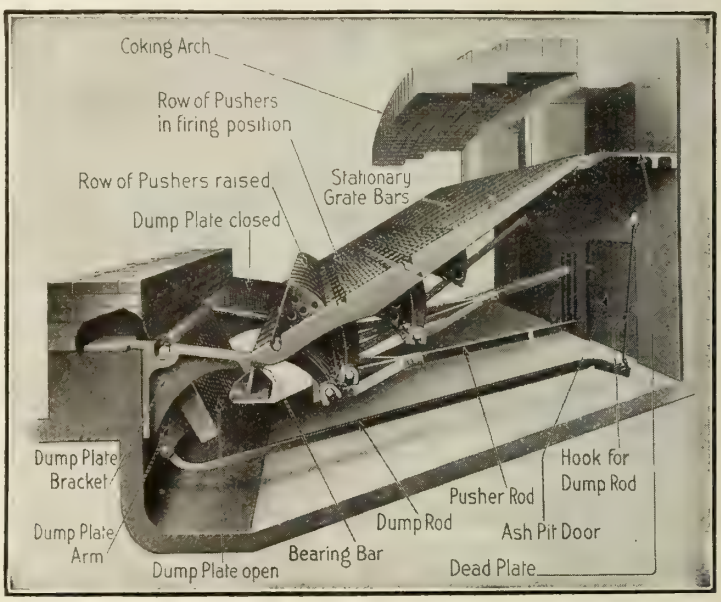
Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
(Formerly Jones Cold Store Co.)
HAGERSTOWN - MARYLAND, U.S.A

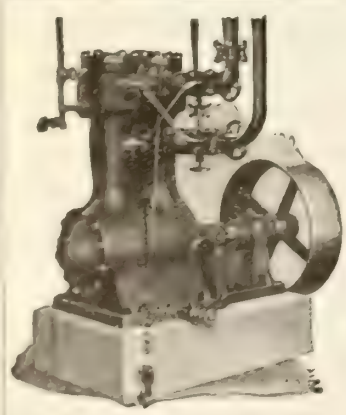
What About The Coal Strike?

The coal piles are going down—and the strike isn't over! Doesn't this teach sensible men to practise real economy in the boiler room? The National Hand Fired Stoker gets you the results with a small equipment of the big automatic stokers that are too costly for you. The National shows a 30 per cent. saving in your coal—gets excellent results with any grade of fuel and any "green" hand can do perfect stoking with it.

Made in St. Catharines. Let us send you illustrated booklet.



Engineering & Machine Works of Canada, Limited
ST. CATHARINES, ONT.
Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada
CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company
242 Beecher St. - - - Milwaukee, Wisconsin

Asphalt mastic finished Nonpareil Corkboard Insulation on one of the rooms of the Avondale Ice Company, Cincinnati, Ohio.

Getting Results with Insulation

Getting results with cold storage insulation depends as much on proper planning as on the material itself. Unless the insulating material is specifically adapted in thickness and method of erection to the conditions in your plant, it cannot be economical and may not be permanent.

The predominating superiority of Nonpareil Corkboard Insulation is not due entirely to the efficiency and durability of the *Insulating Material* —Nonpareil Corkboard. Equally important is the technical service which designs your insulation in thickness and structural detail to suit your requirements and to give you the maximum value in operating economy and investment return.

Instead of worrying with the technical details of materials, thickness and construction, why not enlist the help of those whose business it is to know these things? This Company offers you, without charge or obligation, the assistance of trained men to analyze your plant conditions and to work out the methods of insulation that will give you the most economical and permanent results.

"Ask Armstrong" is the advice you will get from operators and engineers who have learned to depend for results on Nonpareil Corkboard Insulation.

Write for the 152-page book, "Nonpareil Corkboard Insulation." It contains essential facts about insulating low temperature rooms which you will find both helpful and interesting. No charge.

Armstrong Cork & Insulation Company, Ltd.
503 McGill Bldg., Montreal, 11 Brant St., Toronto,

Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines, coolers, tanks and cold surfaces generally; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

NONPAREIL CORKBOARD INSULATION
For All Cold Storage Rooms

More Than Ten Years' Service

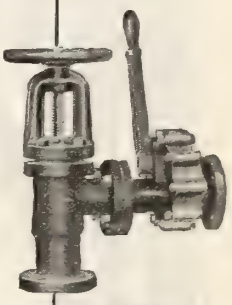
Not One Cent for Repairs

The two Yarway Seatless Blow-Off Valves shown below are in the plant of the Riverside Highland Water Co., Colton, Cal.

These valves have been in continuous service since their installation in February, 1912. One has never been repacked; the other was repacked once.

The packing used was furnished with the original order, so these two valves have not cost one cent for repairs in ten years of service. Recently, they were reported both absolutely tight.

Records like this indicate one reason why so many careful, economical operators prefer the Yarway Seatless Blow-Off Valve. The whole story is told in Booklet B-410—awaiting your request.

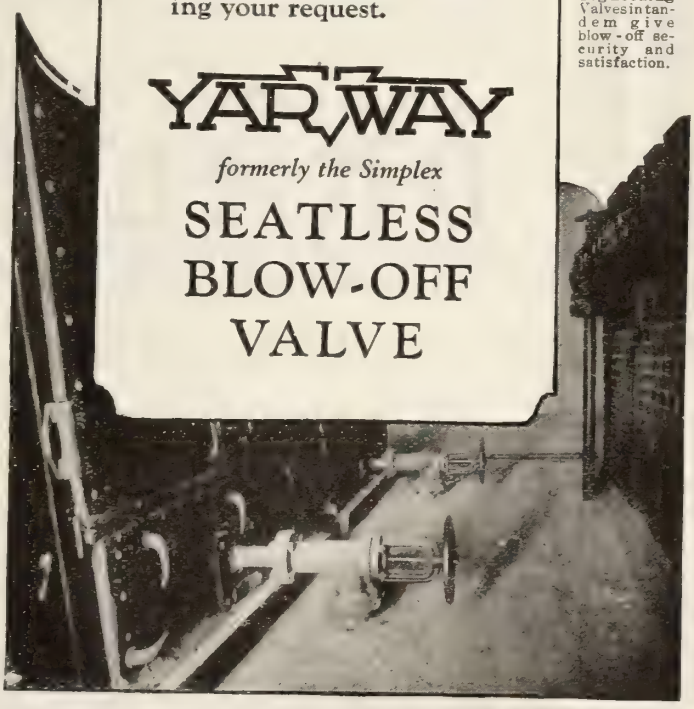


If you require two valves on the blow-off line, remember this: the Yarway Seatless and Yarway Double Tightening Valves in tandem give blow-off security and satisfaction.

YARWAY

formerly the Simplex

SEATLESS BLOW-OFF VALVE



·YARNALL·WARING·COMPANY·
7604-20 Queen Street
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Representatives in all Principal Cities
For Complete List of Offices see Sweet's Engineering Catalog-Keystone Mining Catalog or Chemical Catalog

YARWAY SEATLESS BLOW-OFF VALVE··YARWAY DOUBLE TIGHTENING BLOW-OFF VALVE··YARWAY BOILER SKIMMER··YARWAY ADJUSTABLE SPRAY HEAD··YARWAY HYDRAULIC VALVE··YARWAY UNLOADER YARWAY-LEA V-NOTCH METER·· YARWAY ·· YARWAY PIPE CLAMPS ETC
POWER PLANT DEVICES

Genuine British Oak Tanned Belting

Put it to this test---

If you have a particularly difficult problem in transmission—one for which ordinary belting has proved unsatisfactory—put a D. K. McLaren British Oak Tanned Belt to work and you will appreciate, as others have done, its wonderful toughness and pliability. This extraordinary gripping power (preventing slippage and other trouble) is the direct result of the long-time process of British Oak Tanning to which it is subjected. It is the reason back of our claim that D. K. McLaren Belting reduces transmission costs to a minimum.

D·K·McLAREN
LIMITED

Head Office and Factory:
351 St. James St., Montreal, P.Q.

Toronto, Ont. 194 King St. West.
St. John, N. B. 90 Germain St.
Calgary, Alta. Gormans Limited.
Edmonton, Alta. Gormans Limited
Vancouver, B. C. Gormans Ltd. 1158 Homer St

Taking the "stuff" out of stuffing boxes

Making packing tight by screwing up the gland creates friction that destroys the packing and wastes power.

That's why Sea Rings are different — they require only sufficient gland pressure to prevent their moving in the stuffing box.

The lips of Sea Rings are adjusted by the action of the pressure they pack against, tightening as the pressure increases and loosening as the pressure drops. The pliant lips of Sea Rings bear on the rod with the minimum pressure necessary to prevent leakage.

Packing life is prolonged by removing the cause of its destruction. As a result, Sea Rings will outlast ordinary packings many times over.

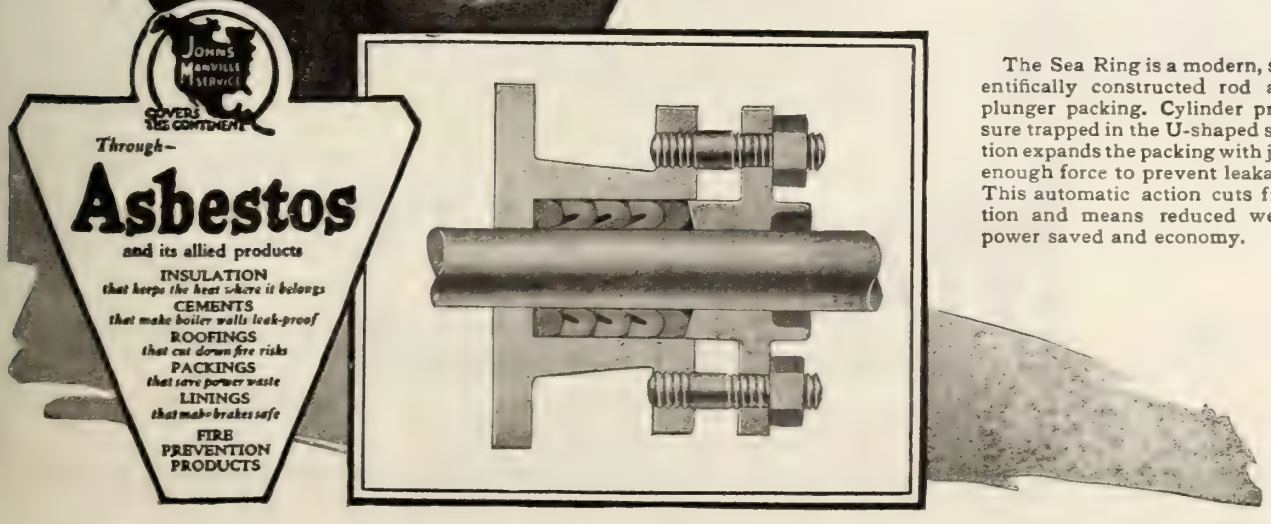
That is not all. Reduced friction saves power — it actually cuts your power cost. Sea Rings are saving thousands of dollars yearly in many plants.

The Tidewater Paper Company made one of the many tests that have proven the actual saving effected by Sea Rings. The Sea Ring Booklet gives the results. Send for it.

CANADIAN JOHNS-MANVILLE CO. LTD.

Toronto Montreal Winnipeg Vancouver
Windsor Ottawa

JOHNS-MANVILLE
Power Plant Materials



The Sea Ring is a modern, scientifically constructed rod and plunger packing. Cylinder pressure trapped in the U-shaped section expands the packing with just enough force to prevent leakage. This automatic action cuts friction and means reduced wear, power saved and economy.

Johns Manville Service
Covers the Continent

Through—

Asbestos

and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

"Shooting" the Man from Glengarry

THE Ottawa Valley has witnessed scenes during the past few weeks which have never before greeted the eyes of the dwellers within its limits. Realism—the sinewy log drivers, cleverly and daringly facing the camera; beautiful women rescued from the river's icy waters—terrific raft fights—log jams, where lean river men stepped from the playing of a part into real life—lumbermen armed with peevies and pike-poles, striving to break the menace of locked logs—all these are features of the most stupendous Canadian story yet filmed within the borders of this Dominion.

Ernest W. Shipman has been producing "The Man From Glengarry," Ralph Connor's masterpiece—and filming it with all the fidelity and accuracy which modern ingenuity can command. Those who have been privileged to witness these scenes have watched in action pretty, vivacious Mayme St. Clair, Bully Lenoir and Big MacDonald, reproducing the action contained between the covers of Ralph Connor's dramatic work.

Archie McKishnie has recently spent several days with Mr. Shipman's company and has told the story, in

What Does the League Mean to You?

By

Sir GEORGE E. FOSTER

An account of the activities of the League of Nations during its two years' existence; of the Canadians who have been connected with its work; some cogent reasons why you should be vitally interested.

July 1st issue of MacLean's

Other Fact and Fiction Features

THE MAN WHO COULD NOT GET DRUNK—"Sapper" H. C. McNeile.

AT THE SIGN OF MERCURY—by Maurice LeBlanc.

G SHARP—by Guy Morton.

LONE WOLF OF THE WHEAT PIT—Charles Christopher Jenkins.

OVER THE BORDER—by Bertrand W. Sinclair.

WEASEL CALF'S LAST DANCE—by Nicholas North.

THE UNCONSIDERED ELEMENT—by Charles G. Booth.

OVINGTON'S BANK—by Stanley J. Weyman.

HOW THE MANUFACTURERS MUST DEPEND ON FARMERS—by Prof. G. E. Jackson.

THE GIRL WHO GOES TO BUSINESS—by Gertrude E. S. Pringle.

OUT-OF-DOORS IN CANADA—A Page for Scoutmasters.

A NEW COAT FOR OUR FIFTY-FIFTH BIRTHDAY—Prof. W. T. Allison.

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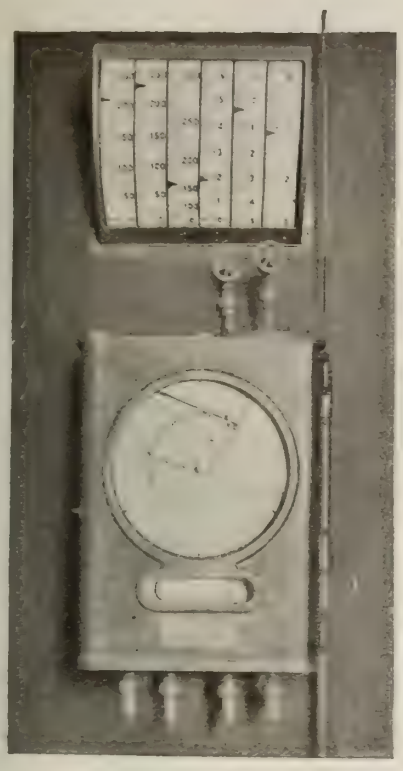

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With the various details of the many operations clearly indicated; with draft, stoker and other controls at hand; the operator can operate the boilers as easily and intelligently as the switchboard man handles the electrical load in a central station. With the Bailey Boiler Panel, a combination of the Bailey Multi-Pointer Gage and Bailey Boiler Meter, the operator has everything right before him to obtain the desired capacity and best efficiency at all times.

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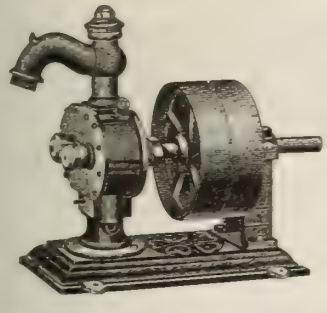

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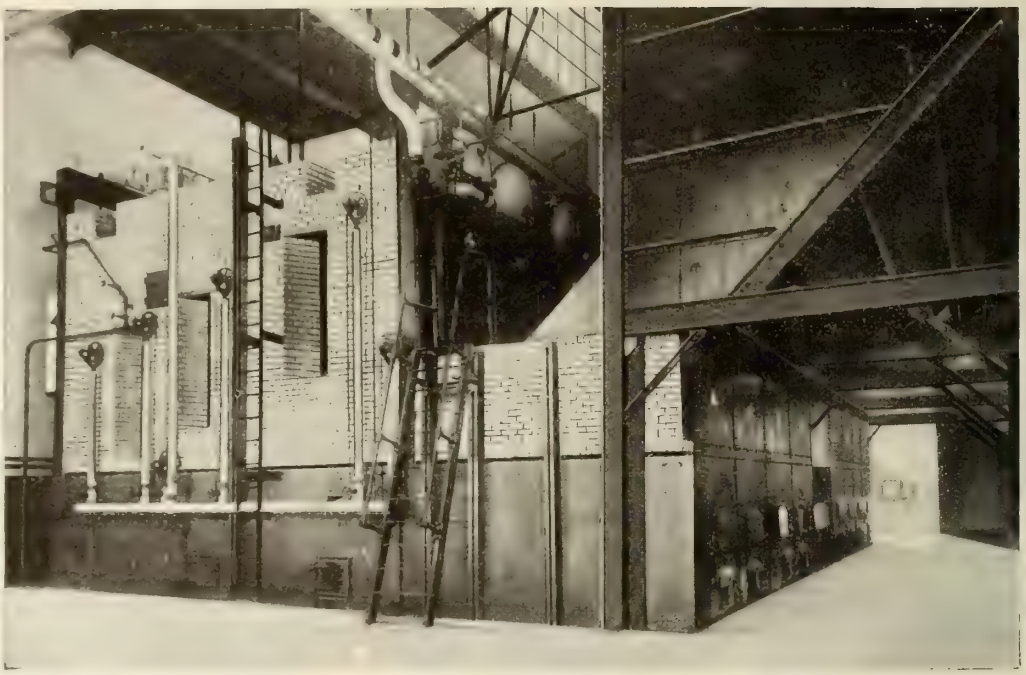

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Illustration shows installation at plant of the Log Supply Co., Limited, Bertierville, Quebec.

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POWER HOUSE

Members of the Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

The Thirty-Third C. A. S. E. Convention

Some Changes Looking to the Advancement of the Association Were Made in the Constitution—Interesting Lecture on Flow Meters—Picnic, Dancing and Social Activities Provide the Lighter Side

ANOTHER convention of the Canadian Association of Stationary Engineers has gone into the pages of history, and the eyes of the members are now turned toward the future and other conventions.

It is unfortunately true that there was not as large an attendance at this year's event as there has been at some of the others, at least so it seemed to those who had goods on exhibition there, but perhaps one reason was that strangers seemed to have considerable difficulty in finding the hall. To the inhabitants of the town it was a familiar spot, but to a visitor it presented difficulties. Owing to the fact that there was a sign outside exhibiting the initials Y. W. C. A., some of the more bashful visitors hesitated about entering.

The Official Opening

The real opening of the convention was on the Tuesday morning, although on the previous evening the Grand Lodge held an executive meeting, this being of course in camera. During the evening while this was going on the exhibitors were busy getting their stalls in order for the following day, and some of them found then that they could not, unfortunately, get their heavier exhibits into place. However, they made the best of it, and used unlimited quantities of crepe paper and bunting to hide the deficiencies. At 10 o'clock on Tuesday morning the various delegates, members of the Grand Lodge, exhibitors and visitors, assembled in the hall of the Dominion Tire Systems to officially declare the meeting open. There were present in addition to the officers of the C. A. S. E. the Mayor of Kitchener, Mr. Charles Greb, and Mr. Nicholas Asmussen, the M. P. P.

The president of the local Lodge, Mr. Pflug, introduced the mayor in a brief speech, in which he spoke of the advantages of the town as a manufacturing and residential city. The Mayor, on rising, welcomed the delegates, exhibitors, and visitors to the city, and passed some complimentary remarks on the exhibit in the adjoining room. He wished everybody present to enjoy the advantages of the city to the full during their stay.

Mr. Asmussen, following the Mayor, regretted the fact that they could not display all the hospitality that they had on former occasions of the convention being held in Kitchener. He won the sympathy of the majority of those present, by stating that he hoped that in the near future, the legislature would pass saner legislation, which did not interfere so much with the tastes of the general public, and would give them back the freedom which had been such a strong point with their forefathers. From the cheers with which these sentiments were received, there were not many present who were in favor of prohibition.

President Harper of the Grand Lodge explained in a few words just what the objects of the Association really were. He stressed the fact that its great reason for existence was the facilities it held out for engineers to improve thier knowledge of their profession, and become more valuable men to both themselves and the community in general.

Exhibitors, Delegates, Ladies and Visitors in Victoria Ball Park.

While it was a fraternal society in a way, this was overshadowed by its educational features.

Mr. J. Thompson of the Dearborn Chemical Co., spoke a few words in commendation of the city, and pointed out to the mayor that he had neglected to offer the convention the freedom of the city. The Mayor promptly rose and rectified this omission.

Mr. Soucy, a delegate from Toronto, also spoke as one who knew Kitchener from the fact of having lived in it for a number of years, and had many words of praise to give.

Mr. T. H. Fenner, editor of Power House, also addressed the meeting, as did Mr. Gordon Keith, editor of "Canadian Manufacturer."

Mr. Harry Wright, delegate from Montreal, and the Vice President of the Association, (now the President), departed from the subject in hand long enough to give the assemblage a recipe for making Californian bee wine. It appears this Californian bee is a species of plant, which can be induced to yield a tasteful liquor if properly treated. It developed that in Mr. Wright's capable hands it accumulated quite a sting, and this not being enough for the jaded throats of the Montrealers, he added a little whiskey and port wine. The meeting listened with great approval, and Mr. Wright thereon developed another theory on the capabilities of cocoanuts if mixed with the right constituents.

Leaving this fascinating subject, he came back to the purposes and advantages of the C. A. S. E., and especially pointed out the advantage it might be to the man in the smaller town, and the smaller plant, who did not get the opportunity of seeing for himself the more modern developments in power plant work. These men, through intercourse with the other branches of the society, and by the fact that there were lectures delivered from time to time on these subjects, could at least become familiar in a general way with things they would otherwise never meet. He also pointed out how the technical papers, such as the Power House, could help them, and alluded to the support this paper had given to the organization.

A few words from Mr. L. J. Ellis, the Grand Secretary of the Association, concluded the proceedings.

Adjournment was then made to the Exhibition Hall where the following firms had their goods on display:—

Jas. Morrison Brass Manufacturing Co., Toronto, valves, injectors, gauges.

Babcock and Wilcox Co., Montreal, boilers and accessories.

Black Donald Graphite Co., Calabogie, graphite products.

Darling Bros. Montreal, heating appliances, valve re-seating tools, etc.

C. B. Turner and Co., Toronto, boiler scale separator, and tube ferrules.

Empire Brass Manufacturing Co., London, valves, etc.

Thompson, Gordon Co., Hamilton, packing, etc.

Waterous Engine Works, Brantford, exhibiting Files stokers.

Goldie and McCulloch, Galt, engines, boilers, Rees Roturbo pumps.

Quaker City Rubber Co., Philadelphia, packings.

Lunkenheimer Co., Cincinnati, valves.

Crane, Ltd., Montreal and Toronto, valves, equipping and fittings.

Garlock Packing Co., Hamilton, packings.

Dearborn Chemical Co., Toronto, boiler scale treatments.

Jenkins Bros., Montreal, valves.

Atlas Machine and Engineering Works Toronto, Attwood Pump.

Power House, Toronto.

Canadian Manufacturer, Toronto.

A drive had been arranged for the ladies of the party for the afternoon but unfortunately the weatherman turned peevish, and this had to be abandoned for the time being.

While the Grand Lodge was in session Tuesday evening, a lecture had been arranged for the entertainment and instruction of the visiting delegates and members of the local lodges, who were not required at the Grand Lodge meeting. This lecture was delivered by Mr. Mess, of the Dominion Flow Meter Co., and the subject was "Flow Meters." The lecture was illustrated by a large number of slides, and it was handled by Mr. Mess in a way that made the construction and operation of these instruments quite plain to all those present.

After the lecture, Mr. T. H. Fenner of the "Power House," by request of the Grand Lodge, gave a short lecture on the aims and objects of the C. A. S. E. to the audience, many of whom were non-members of the Association.

Wednesday's Events

The morning was devoted by the delegates to a session of the Grand Lodge, and the exhibition hall remained open during the morning for those who cared to come. It is rather to be regretted that very few took advantage of this opportunity, for there is no doubt that it would have been an education to a number of them had they done so. It is rather discouraging to those exhibiting, who are put to a considerable amount of expense in preparing and shipping their goods, when so little interest is displayed by those attending the convention. It would be an excellet opportunity for the engineers in the convention town to get their managers, superintendents, or the owners of the firms themselves to visit this exhibition, and get an idea of the various appliances that are manufactured for power plant uses.

The big event as usual was the picnic, at which the delegates and their wives, and friends were the guests of the Exhibitors' Association. The sports events were carried off in the Victoria Park, after the crowd had first been photographed by Mr. Denton, the official photographer, for the occasion. This photograph is reproduced here. The winners of the various events were as follows:

One Hundred Yard Dash:—Geo. Wilkinson, first; J. Thompson, second.

Balloon Race— Doris Lodge, first; Vera Karn, second.

One Foot Hop Race—J. Hughes, first; J. Thompson, second.

Ladies' Candle Race—Mrs. Anneveld, first; Mrs. Kirsche, second.

Backward Running Race—G. F. Galloway, first; W. L. Kohl, second.

Ladies' Clothes Pin Race—Dorothy Ott, first; Mrs. Goften, second.

Men's Smoking Race—Ed. Reiber, first, Wm. Lodge, second.

Potato Race—Bertha Kirsche, first; Mrs. Gofton, second.

Wheelbarrow Race—B. Myer and S. A. Jennings.

Little Boys' Race— Jim Hetherington, first; Ed. Luft, second.

Little Girls' Race—B. Gastemier, first; Mary Taggart, second.

In the soft ball game between the engineers and exhibitors, always a well contested event, the engineers were victorious by 10 runs to 3. The umpire Mr. E. A. Wilkinson, discharged his unpleasant duties with a commendable firmness, though we say nothing about his ability in any other way.

After the ball game everybody departed to their various resting places to prepare for the concert and dance which was to feature the evening. This event was pulled off with the usual eclat, and the dance especially was much enjoyed by all present. Owing to the kindness of Mrs. Ott a good many of the visitors had been able to limber up at a little informal dance held at her house the previous evening.

The prizes for the Educational Contest among the various lodges of the C. A. S. E. resulted in Toronto securing the first prize, with Ottawa, second, and Kitchener third. Kitchener also won the prize for the lodge obtaining the greatest membership during the year.

Get Away Day

Thursday was the winding up day of the Convention. The Grand Lodge officers met and elected the officers for the ensuing year, and after the election Mr. Brown, Chairman of the Board of Stationary Engineers, Mr. Medcalfe, Chief Boiler Inspector of the Province of Ontario, and Mr. T. H. Fenner, editor of "Power House" addressed the Grand Lodge on the subject of the boiler and stationary engineers' acts, and their administration.

Mr. Brown made it clear to the officers of the Grand Lodge that there was nothing to fear from the special certificates which have been discussed at some length in this paper. Mr. Medcalfe spoke on the administration of the boiler inspection laws, and pointed out where certain weaknesses lay in the acts appertaining to the inspection of boilers.

The following officers were appointed for the ensuing year, and were installed the same afternoon:

Delegates With Their Ladies.

MEMBERS OF GRAND LODGE.
Top Row: R. E. Arnup, Woodstock, Conductor. F. Harper, Kingston, P.P., Galloway, London, V.P.
Bottom Row:—L. J. Ellis, Hamilton, Secretary. H. Wright, Montreal, President. J. J. Sullivan, Ottawa, Treasurer. T. Turner, Toronto, Doorkeeper.

H. Wright, Montreal, President.
F. H rper, Kingston, Past President.
J. Galloway, London, Vice-President.
L. J. Ellis, Hamilton, Recording Secretary.
R. E. Arnup, Woodstock, Conductor.
T. Turner, Toronto, Doorkeeper.

Probably the most important work performed at the convention as far as the Association is concerned was the amendment of the constitution, by which the ritual formerly in use h s been practically abolished. We shall be able to give further particulars in a future issue in this regard.

The exhibitors association also held their annual meeting on Thursday morning, the 28th June, the general routine business being gone through. There was, however, one resolution of extreme importance which probably has considerable significance to the C. A. S. E. and future convention success. It is as follows:—

"It is hereby resolved that before the Exhibitors Association meet at the point chosen by the Grand Lodge of the C. A. S. E. that the President of the Exhibitors Association get in touch with the local lodge, and find out what facilities they have provided for holding an exhibition, and, if they have not proper facilities, the executive of the Exhibitors Association is to select their own place of meeting."

The following gentlemen were elected to hold office for the ensuing year:

President, J. Thompson, Toronto.
1st V. P., H. Fletcher; Toronto.
2nd V. P. E. Hetherington; Galt.
Secretary, G. Keith; Toronto.
Ass. Sec., Geo. Wilkinson.
Treasurer, R. M. Archibald; Toronto.
Chairman of Committees:—
Exhibition, C. B. Turner.
Entertainment, E. Hetherington.
Reception, H. H. Gee.

The place of next year's convention will be Toronto, and it will be held as usual in the last week in June.

£10,000 FOR RESEARCH

The name of Parsons is known all the world over in connection with the invention of the steam turbine which has made possible the cheap production of electricity in large quantities and the development of high speeds by large ships. In addition to inventing the turbine Sir Charles Parsons has rendered great service to the progress of science and the latest sign of his interest in the field is the gift of ten thousand pounds to the British Association for the Advancement of Science. Since it was founded in 1831, the Association has made grants of over eighty thousand pounds towards scientific research. Sir Charles' latest gift will enable the Association to maintain its important work of scientific investigation. In connection with the speed of ships it is interesting to note that the fastest ship afloat is a British vessel, the "Mauretania," and during a recent voyage from the United States to Great Britain she maintained an average speed of 25.14 knots, and at one stage she attained 27.5 knots. This was the fastest trans-atlantic cruise made since the war, and it is faster than the same vessel had ever attained.

NEW PUBLICATIONS

A line of velocity stage turbines especially designed for high pressure and high temperature steam is described in a 28-page catalog issued by the De Laval Steam Turbine Co., of Trenton, N. J. The cast steel steam chest is located in the casing cover in order to avoid the conduction of heat to the bearings. In addition to the speed governor and governor valve, there is an independent valve controlled by an automatic overspeed trip. The turbines are built in sizes up to 1,200 h.p., and are designed to be directly coupled to high speed centrifugal pumps and blowers, small AC and DC generators, and by means of double helical speed reducing gears, to large pumps and blowers, medium size generators, belt pulleys, rope sheaves and slow and moderate speed machinery.

The Conveyors Corporation of America, 326 West Madison Street, Chicago, Ill., have just issued a new booklet describing their American Cast Iron Storage Tank, which is designed for holding loose, bulky, dry materials for storage or transfer. The tank is sectional and may be secured in a number of sizes.

The booklet is illustrated with engravings showing the tanks in use at a number of well known plants. Diagrams give details of construction and a comprehensive table of weights and measures is included.

Copies of the booklet may be secured by addressing the Conveyors Corporation at 326 West Madison Street, Chicago, or on application to their district representatives.

The Bureau of Labor, Province of Manitoba, have issued a book containing the Inter-Provincial Boiler Regulations. No doubt these books will be available to Ontario manufacturers and boiler users very shortly, but we understand that at the moment they are not all off the press. The book contains complete information on preparation of designs, tests, etc. to satisfy the regulations of the provinces agreeing to the regulations, which include British Columbia, Saskatchewan, Manitoba, Alberta, Ontario, Quebec and Nova Scotia. The regulations are intended to serve the double purpose of ensuring safe boilers, and at the same time standardising design and construction, with the advantages accruing to both manufacturers and users from such standardisation.

Some More Discussion on Burning Wood Fuel

The Search for the Most Efficient Method of Burning a Mixture of Wood and Coal is Continued and Some Valuable Thoughts Are Brought to Light in the Process

By "JOHNNY SHOVEL"

AS WE said before, everybody had a theory as to how the conditions at the mill could be improved and the firemen were not so exclusive that they stood out of it. Quite the opposite, and bless them, they didn't stop at the furnaces, but joined forces in condemning the boilers as well.

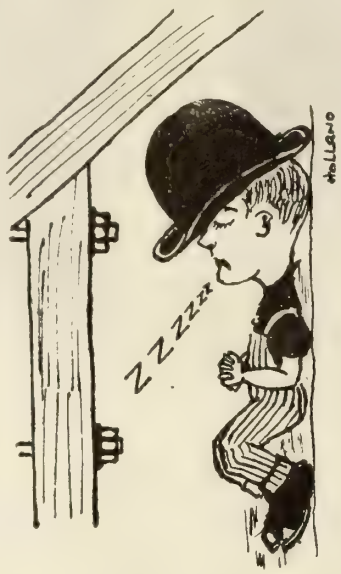
With our personal education they had a great deal to do and while they looked down on us owing to our lack of years, and depreciated our efforts in rough language, they gradually came to interest themselves in our search for knowledge. Probably they came to believe that we were filled with "insatiable curiosity" and like Kipling's "elephant child," it would lead us to something better. Without the knowledge of the "powers" they gave us a hand to find out how to suit the fire to the quantity of stuff coming over.

He was a curler.

First we tried mixing the shavings with coal before we put them into the furnace, because it is not very easy to throw a shovelful of shavings to the back of a 7-ft. furnace. They have to be mixed with saw-dust or coal or they will not make the distance, no matter how much force is used.

After a time we discovered that every boiler was an individual as far as the dampers were concerned, a TRUTH which applies to ANY boiler wherever it may be and whatever the furnace or fuel. In this case we wanted to get a strong draft but not so fierce that it would carry a lot of the fuel over into the boiler. With the help of a quantity of dry shavings we were able to establish this limit for each unit.

We had only the steam pressure gauges and the quantities of coal in the cars to estimate with and naturally there was a lot of argument, but it eventually became the rule, when we were getting plenty of stuff from the mill, to fire heavily with the stuff and then bed the coal on top.



No man who works in constant danger of hitting his head should be without one. It gives such a wonderful feeling of security if your favorite place to sneak a nap happens to be restricted.

This is the second of a series of articles on the practical operation of boilers by a man well qualified to speak on the subject. He is writing them in plain language, and avoiding technicalities. There will be a fund of information found in these articles for all classes of engineers.

The cap kept the dust out pretty well, and by ignoring the injured looks of our landlady when she would discourse with us on the washing of dirty pillow cases, we managed to get away with only one really truly head wash each week.

When we had to burn half and half, we found it a good plan to make a thick coal fire at the bridgewall, tapering it off to the grate about four feet out. We could keep this fire in good shape by feeding coal to it over top of the stuff, and we could fire any kind of stuff in front. The scheme had the added advantage that if the blower was not sending us much, it was easy to bring the coal fire along to the required size, even to cover the grates. Reversely, it was a simple matter, if the stuff began to pile up on us, to shove the coal fire to the rear of the grate and fire with it again.

The saving in coal was something and the improvement from the firemen's point of view quite appreciable. They were more comfortable in mind, but still there was no necessity for any worker in that boiler room to be rocked to sleep.

We hear that the boys back from overseas have gone one better by wearing their 'tinlids' and they go about their business with a most complacent smile regardless.

Our master mechanic was a Scotsman, and a great curler. It was not to be expected that our efforts could escape him, but we were surprised and we understood that our energy had been properly appreciated, when he stopped one day to remark "Some day laddie, we'll make a guid stane man o' ye." The height of praise from the gentleman was that "it's no so bad," and to be considered as a possible member of the "Curling Club" was an honor almost overwhelming.

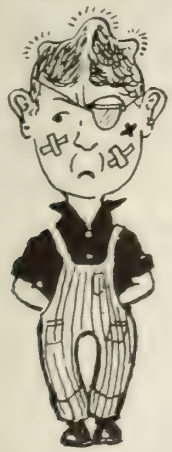
The biggest lumber company in our district had their largest mill about 15 miles from town. One day we were struck with the mighty fact that they certainly burned wood there if any place in the country, and the views of the man in charge would be interesting.

He Got An Order.

So, we made up to the boys of the "shunter" crew and finally got a free ride to the forks. We rode in the engine. My word, it was a wonderful trip. The time passed all too quickly while we picked up full cars here and there and placed "empties." We were firmly convinced that when we got back home we would apply to the railroad for a job and become a locomotive engineer.

That thought didn't stay very long. The size and class of the equipment at the saw mill surprised every other idea out of our heads. We were, almost, afraid to talk up to the men working there, we felt so humble in the midst of, to us, ponderous machines. The "chief" was good enough to take us in hand and explain all we could absorb about the equipment under his charge. He was one of those long, thin individuals who do not show their age, but his stories indicated that he had been a long time in the business.

"Yes", he said, "burning wood is getting to be more of an art these days. Most of the stick is marketable and they ship out everything that will make a match. There is nothing like the same amount of wastage, and since what



We started to work with the idea that a cap worn on an inside job would take all the hair off our head. We didn't wear one till we got good and tired of washing our hair and mending the bruises and cuts where our head met sundry obstruction.

is left is supposed to make the steam needed to keep everything going just the same, one has to use some judgment in burning it." After we had sketched our layout for him and told all we knew about conditions, he concluded, "that if he had to do the job, he would put in an 'Extension Furnace.' nil. You need plenty of combustion space, but there is not enough moisture in that stuff of yours to require a Dutch oven. Our stuff here is straight out of the mill pond and we have to have a lot of heated brickwork to radiate heat to it and drive the moisture out.

"Since you have H. R. T. boilers, you have to figure on getting your combustion straight along the shell. Space is space whether it lies horizontally or vertically, but the distance from the grates to the shell should be more than most people allow, say about 5 feet, so the stuff can pile up in a cone under the feed holes. Your Joe Leblanc, in his high set B. & W. boilers, has enough furnace volume to burn his stuff without extension furnaces. Rated by the quantity of moisture, he is at one end of the wood fuel burning game and you are about half way between him and me. If you had B. & W. boilers, set a bit higher than Joe's, you might burn

It didn't stop the bruises nor all the cuts. A light cap is poor protection against the end of a bolt that wishes to slay you. We still saw stars very often. One day we got a bang that made us see daylight, and immediately we promoted ourself to a hard hat.

your stuff without the extension furnace."

We had thought, from what our mill engineer told us, that all Dutch Oven furnaces had grates slanting to the boiler, but the grates at this sawmill were flat. Mr. Dobson said he had been in Newfoundland at one time, working for a British firm, and the grates in that mill were slanting. He thought it was British practice to arrange them that way and with the chutes leading into hoppers outside the furnace altogether, so the stuff would roll along down the grates without piling in heaps. The practice of having the grates flat was American, but the effect was really just about the same, for the slanting grate was represented by the cones under the feed holes.

They were "hogging" most of t' wood, that is, passing it through a machine which ground it to shreds. It traveled to the furnaces by conveyers,

passed down the chutes and piled up on the grates in cones about four feet high, each chute feeding something like 32 sq. ft. of grate. We got another surprise at seeing clinkers coming from one of his boilers. "How did they get it?" "Well, that boiler was the first on the conveyer and nearly all the earthy material, picked up by the logs while coming down from the woods to the mill, fell into that furnace and it made clinkers just as the same ingredients in coal would and did make. It is not wise to try and clean that fire. In fact, it is plain dangerous and we have had a good many firemen burned because they would take a chance and stick a hoe into a cone. The interior of the cone seems to contain steam or gas which explodes when the necessary air gets through it, and Mr. Fireman is caught by the rush of flame through the fire door. It doesn't always explode; they get away with it, only to find that pulling down the cone puts the fire out around the edges of it.

"Our load is reasonably steady, but we have things arranged so that we can take care of a demand for more steam. We have the feed holes on two furnaces set six inches nearer the boilers than the others, so the front of the grates

All He Had To Do.

has a longer bare space. When the demand for extra steam comes, we fire blocks and slabs in the front end of these furnaces and 'hump' them up above rating."

Of course, the fact that the firm was considering a change, got to the ears of every supply man in the district and we had a good many of them down to look over the proposition. Some of them made suggestions and some promised miracles. Most of them contributed to the general fund of information, so that the boss was able to base his report on a real knowledge of the conditions. The firm went thoroughly into it and one result was, that afterwards all the timber they brought from distant points came "dimensioned" so there was nothing much to come off it and nothing like the same amount of stuff coming over to burn. Guess they figured it was cheaper to have the sticks made to size than to pay freight on a lot of wood whose value as fuel didn't pay it by a long shot.

As for the actual question, it wa solved in a very different manner from what our wise ones expected. A salesman for underfeed stokers dropped in, made a bargain for his machines and got away before we had a chance to tap his store of knowledge or even get a few of the latest stories. The stokers arived promptly and we fitted a boiler each week till they were all in place.

Say, but we were proud of those things for the first while, but still it was a busy job, for the stuff from the mill and the coal had to be shovelled into the hoppers. What was the best way to burn it? Mix it all together? Fire coal and then shavings? Or fire all the coal by stoker and the shavings in the good old way, through the fire doors? After some experimenting, this last method proved to be the best for us. The next spring the boilers were raised and the chutes arranged so what stuff there was dropped straight into the furnace, then the firemens' energies were expended on the valve chains.

HOW MUCH POWER IS THAT BELT TRANSMITTING?

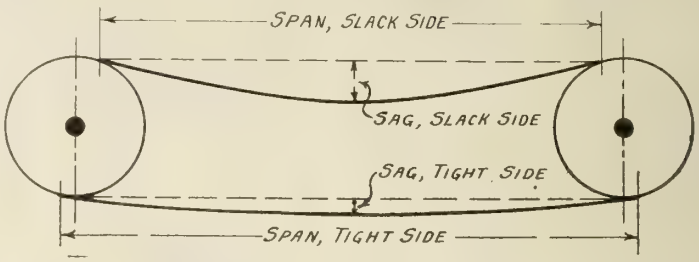
(A method that gives the answer without the use of complicated instruments.)

By W. F. Schaphorst

When a horizontal belt is in operation, and most important drive belts are horizontal or nearly so, it is a well known fact that no matter how great the load that is being transmitted there is a sag in the "tight" side of the belt as well as in the slack side. It is impossible to make the pull so great that the tight side will be perfectly horizontal, or a perfect straight line. There will always be a sag. The greater the load, the less the sag on the tight side and the more the sag on the slack side.

In view of the fact that this sag on both sides varies with the load being transmitted and in view of the further fact that the tension in a belt can be accurately computed when the sag and span are known, it becomes possible to compute the power being transmitted by any horizontal belt. To assist in these computations the writer has prepared a table which is reproduced herewith. It is a simple matter to measure the sag and the span with an ordinary yardstick. Four other measurements are necessary—the width and thickness of the belt; the outside diameter of one of the pulleys; and the revolutions per minute of that same pulley. These measurements may all be taken with the same yard stick and with an ordinary watch.

To determine the horsepower being transmitted by a given leather belt of any width and thickness, measure the span of the slack side as indicated on the sketch. This span is NOT the distance from center to center of the shaft but is the distance between the points where the belt leaves one pulley and touches the other. Then measure the sag. The sag is the greatest vertical distance between the belt and a straight line connecting the contact points as shown on the sketch. Next, measure the span and sag of the tight side again, observing the points of "making and breaking contact" as explained above. It makes no difference whether the belt is a "bottom pull" or "top pull" belt, this method will give the horse power transmitted in either case. Then, referring to the table, find the tension corresponding to the span and sag of the slack side, which we will call A. Then find the tension corresponding to the span and sag of the tight side, which we will call B. Subtract A from B. Then multiply by the width of the belt in inches. Then multiply by the thickness of the belt in inches. Then multiply by the outside diameter of one of the pulleys in inches. Then multiply by the revolutions per minute made by that same pulley. Then multiply by .000007933. The answer is the horse power being transmitted by the belt at the same time of measurement.



Finding the power a belt is transmitting

In case the sag is less than one inch, which may often be the case where pulleys are close together, this same table can be used by simply shifting the decimal point to the right. Thus if the span is 10 ft. and the sag is 0.6 in. instead of 6 in. the tension would be 105 lbs. instead of 10.5. If the span is 12 ft. and the sag 0.1 inch, the tension would be 907 pounds instead of 90.7. In case the actual span of the belt does not agree with the span given in the table it is a simple matter to "estimate" the tension from the table. For example if the span is 8 ft. 6 inches and the sag is 1 inch. The tension would be midway between 40.3 and 51. To find this midpoint add the two figures together and divide by two. The answer is 45.65. Another way is to subtract the two members (50—40.3) which gives a difference of 10.7 in. Then divide this by two (10.7÷2) and we get 5.35. Lastly, add this to the smaller number (40.3+5.35) and we get the same answer:—45.65 pounds per square inch.

FEED WATER CONTROL

"Regulating Boiler Feed Water" is the title of a booklet which has just been published by the Northern Equipment Company, Erie, Pa. The subject has been treated in an entirely new way, the object being to cover the subject of boiler feed water regulation completely and yet very briefly. To accomplish this purpose, free use has been made of a graphical method of presentation; charts showing the effect of feed water regulation on water input, steam output, feed water temperature, etc., also other charts, photographs, etc. There are only twenty pages and the booklet can be read in less than fifteen minutes.

POWDERED FUEL EQUIPMENT

The Combustion Engineering Co., New York, have issued in booklet form the paper read by Mr. H. D. Savage, relating to the powdered fuel equipment at the Rouge River plant of the Ford Motor Co. This is a very interesting description of an unusual installation, and includes the discussion following the reading of the paper. The bulletin is illustrated with views of the burners employed, as well as a cross section through the boilers, while at the back of the book is a reproduction of a typical steam flow chart, steam temperature chart, and stack gas temperature chart as obtained from the plant.

STOKER COMPANIES MERGE

The Sanford Riley Stoker Co. has merged its interests with the Underfeed Stoker Company of America and its affiliated companies, the A. W. Cash Co., valve manufaiturers, Decatur, Ill., the Craig Damper Regulator Co., Detroit, Michigan and the Underfeed Stoker Co., Ltd., of Canada. The products of the combined companies which include the Jones, Riley and Murphy stokers, make one of the most complete lines of mechanical stokers ever brought together. Manufacturing will be concentrated at Detroit, Michigan and Worcester, Mass., and in Canada at Windsor and St. Thomas.

Mr. R. Sanford Riley becomes president of the combined companies with Mr. F. H. Daniels as vice-president. Mr. S. A. Armstrong continues as vice-president and managing director of the Underfeed Stoker Co. of America.

Economical Design of Steam Piping

By ZUCE KOGAN

The factors that make the economical transmission of steam a complicated matter are the position and the variety of the steam using apparatus. Referring to the variety of machines, we have to consider that each one may possess different characteristics as to the pressure required, and the number of pounds of steam per hour consumed. This means that different diameters of piping are required, and perhaps different quality of piping for different machines.

Steam using apparatus is usually distributed in various parts of a factory. For instance in a sugar factory, the steam engines will be in one part, steam turbines in another, evaporators, juice extractors, driers, etc., all using steam and all in different portions of the plant. The question of economic installation of piping is therefore one that needs consideration, and convenience of repairing, and detecting leaks must be thought of when making the design.

Position of Apparatus

The position of the steam using apparatus is the chief factor which affects the piping lay-out. While it is not possible to arrange the apparatus to suit the piping, it is interesting to see just what could be done in this direction.

First, the machines could be arranged so that their steam connections will be approximately in one straight line. The main and branch pipes will therefore be as short as possible.

Second, the apparatus could be arranged around the boilers, as shown in Fig. 1. This enables the piping to be laid out in a loop form, which is a good way, as it enables any portion of the plant to be shut down while the rest is running.

Another method is that shown in Fig. 2, in which the steam using apparatus is placed around the outside of the building, and the non-steam-using machinery

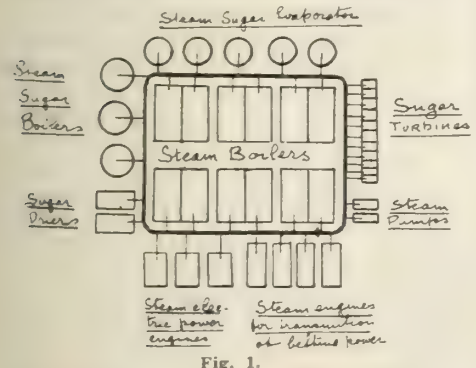


Fig. 1.

in the centre. This possesses the same advantages as the arrangement in Fig. 1.

The installation shown in Fig. 3, while good practice, is much more expensive than the other two, as it requires more branch piping, more losses following as a natural consequence.

Economy of Piping

Considering the piping itself, apart from the placing of the steam-using apparatus, we have to consider the relative lengths of main and branch piping.

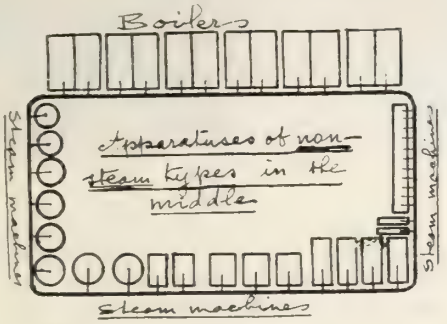


Fig. 2.

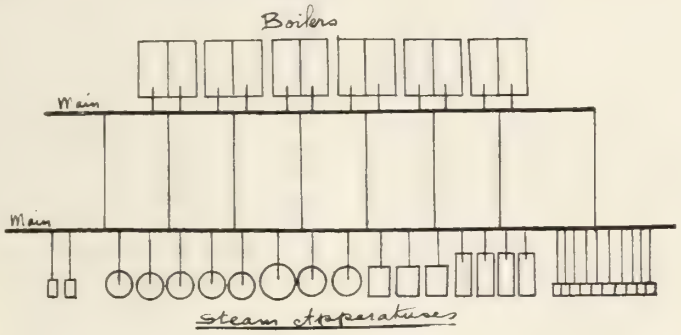


Fig. 3.

The relative cost of these two factors must be looked at from the point of view of initial and operating cost. Regarding the initial cost, the mains being of much larger diameter and weight than the branches, are more costly to buy, and also to install. Thus if initial cost only is to be considered, the natural thing will be to reduce the length of mains, and increase the branches, as their cost comes considerably below that of the mains.

When the working costs are considered it is different. The losses here to be considered are loss of power through drop in pressure due to friction, and loss due to radiation. These losses are greater in small than large pipes, and therefore from this point of view the better plan would be to make the mains longer and decrease the branches.

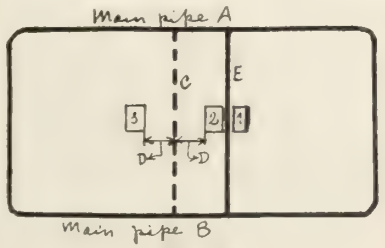


Fig. 4.

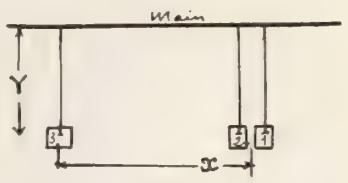


Fig. 5.

In an example like that in Fig. 4, we have three pieces of machinery to connect to the main. This could be connected as shown in Fig. 4, or by means of a loop. Having two distances to consider it is possible to calculate whether the losses of power would be greater with the branch or main piping. When x is small and y is very long, it is more economical to use the main as in Fig. 5. If y is small and x very long it will be obvious that it is bettter to install three branch pipes.

Fig. 5 is an example of a large factory with a main steam loop passing round the building. In the middle of the loop it is necessary to install three machines. These machines may be connected by three branch pipes, but suppose the distance is such as to require the installation of another main. This main would be run from one side to the other at right angles to the two mains. If placed in the position C it would require three lengths of branch pipe D, to connect up, while if the main is installed in the position E it will require only one length of branch pipe D, thus reducing the branch piping about 5 per cent. The economical lay-out of piping requires great study, and the application of the principles of geometry, if initial and working costs are to be reduced to a minimum.

The Atlas One Cylinder Pass-Out Engine

An Engine Developed for Working Economically in Plants Where a Large Heating Demand Exists in Comparison With the Power Requirements, by the Atlas Company, Copenhagen

Courtesy of The Engineer.

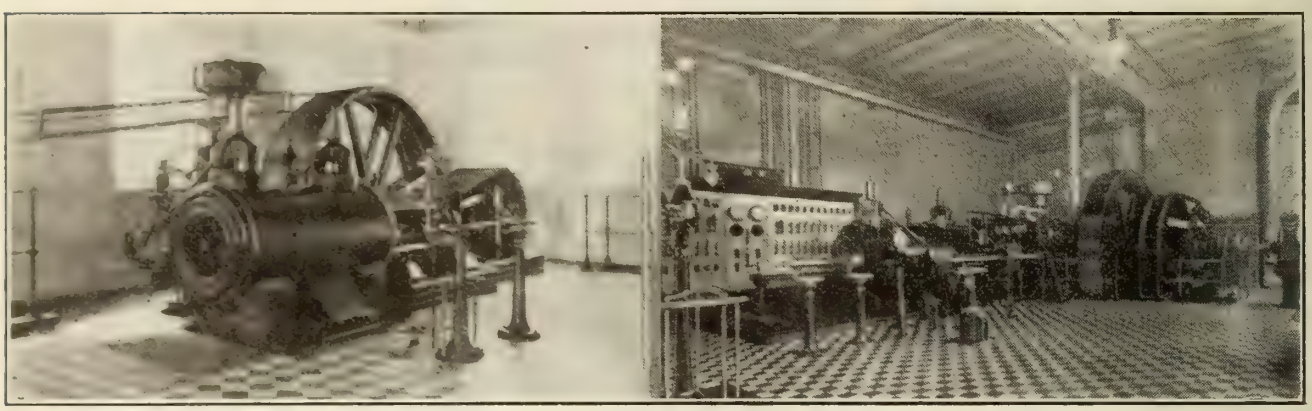


Fig. 1.

IN order to consider in any adequate manner the economical utilization of steam in industry we have to take account of many chemical and industrial processes in which, apart from its main function of furnishing power in a prime mover, a large quantity of steam is also required for heating and other operations. It is perhaps hardly necessary to emphasize that real economy can only be obtained where the two demands are satisfied, and at the same time means are provided to balance automatically the fluctuating loads which will undoubtedly be met with on both the power and heating systems. The advantages which accrue from an installation designed in accordance with these principles are recognized, and in the paper-making industry in particular the pass-out steam turbine is successfully employed. There remain, however, many cases in such industries as paper-making, brewing, dyeing, and the manufacture of chemicals and textiles, where for outputs up to 1,000 horse-power the modern steam engine may be used with profit. The advantage of the steam engine is perhaps most marked where, say, in the case of a brewery, the proportion of power required is small compared with the steam needed for heating, and again where steam for heating is exhausted to the mains at two different pressures.

The problem of the pass-out steam engine has been carefully studied by the Atlas Company, Limited, of Copenhagen, which has, especially during the last few years, supplied a large number of such engines for use in factories in Denmark and Scandinavia, where, on account of the high price of fuel, rigid economy in its use is necessary. The type of engine most frequently adopted is the single-cylinder drop valve design, with a special valve gear, and engines of this pattern have been constructed in sizes varying from 150 horsepower up to 1,000 horsepower. For larger powers two cylinders may be employed. Before describing the patented arrangement of valve gear on the Atlas engine, we may call to mind the conditions under which the normal steam engine works when exhausting steam to heating mains against a fixed back pressure. Unless some regulating device is introduced it is difficult to control the load on the engine so that the exact quantity of steam is admitted to and exhausted from the engine and in nearly all cases uneconomical working cannot be avoided, because any shortage of exhaust steam must be made up by passing additional high-pressure steam into the system through a reducing valve, or, on the other hand when exhaust steam is delivered in excess, any surplus is exhausted to atmosphere through a loaded relief valve.

Valve Gear

The object of designing a pass-out engine is to attain maximum economy of operation by so balancing the load on the two sides of the piston that, on the one side, only the exact quantity of steam required for heating is admitted to the cylinder and exhausted to the condenser or a second heating system. Fig 1 illustrates a 280 horsepower single-cylinder engine working with steam extraction, and in Figs. 3 and 2 we reproduce a section through the engine cylinder and a detailed drawing of the arrangement of the automatic exhaust valves. It will be noted that valves are accommodated in separate end covers, and that the cylinder is a plain casting. Steam is admitted through inlet valves A and B, and is discharged through the exhaust valves C and D to the heating mains E and F. If the engine is fitted for condensing, the simple jet condenser is usually employed, with the air pump driven from the main crank shaft. Control and isolating valves are provided, and the exhaust steam connection to the condenser may be taken from pipe E. The general disposition of the valve gear is indicated in Fig. 4. Double-seated drop valves are employed, and they are operated in the usual manner by excentrics on the horizontal lay shaft. The cut-off is regulated by the speed governor, which controls the opening of the inlet valve, alternating the position of a curved lever which moves between rollers, and is attached to the excentric rod. In addition to controlling the speed of the engine, it is also desired to balance the exhaust steam and power loads, and this is done by turning to account the variation of steam pressure in the heating mains, which variation is used independently to control and to alter the cut-off in that half of the cylinder which is dealing with the heating steam. Thus, when a sudden demand for exhaust steam reduces the pressure in the heating main, the cut-off in one half of the cylinder is automatically lengthened, thereby admitting more steam, but at the same time the cut-off is reduced in the other half of the cylinder, and the balance is thereby maintained. Adjustment may be effected either by hand or by means of a special governor, which is directly controlled by the variation in pressure in the heating system.

We show, in Figs. 5 and 6, the arrangement of the governing gear for a single-cylinder engine with hand adjustment. The lever A on the speed governor is connected by the rod B to two links C, the position of these links being determined by the load on the engine. A block D is provided on each set of links, and this block is capable of independent adjustment by means of a screwed spindle operated by the hand wheel E. The movement of the link block alters the position of the excentric F, which, in turn, varies the cut-off by controlling the inlet valve. The excentric positions for each half of the cylinder may be varied independently, but both are simultaneously governed by the speed gov-

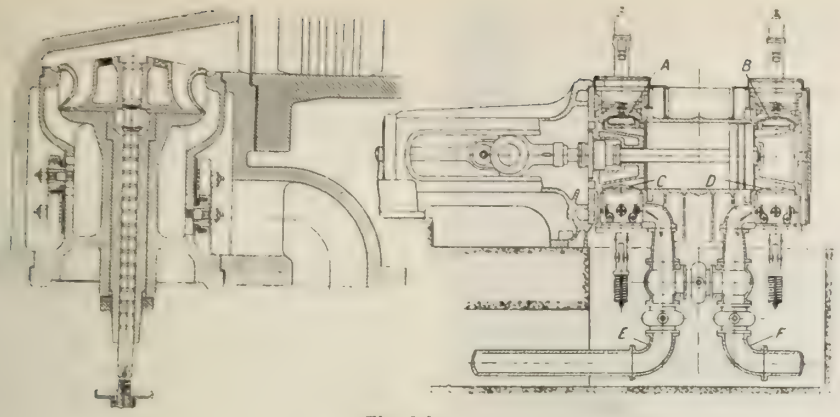


Fig. 2-3.

ernor. In order to prevent the engine racing, should the load at any time be suddenly thrown off, the links are so shaped that the excentric gear will cut-off at zero when the speed governor is in its highest position, regardless of the position of the link blocks in the links. The sketch reproduced in Fig. 7 illustrates diagrammatically the same governing device, but instead of hand adjustment, a special governor is provided which regulates the cut-off automatically. The lettering used in Fig. 7 is the same as that in Fig. 5, and the letters have the same signification, but the additional parts are the steam pressure governor G and the two governing shafts H which operate the excentric gears controlling the inlet valves. It will be seen that the position of the moving parts of the steam governor G is determined by the pressure of the heating steam, and this, in turn, is dependent on the amount of steam passing to the heating mains. Should the load on the engine suddenly increase and cause an amount of steam to pass in excess of the predetermined quantity of exhaust steam, the rise in pressure will cause the piston of the governor to lift, and by means of the double lever the top block D will be moved forward and the bottom block D drawn back. The mechanism is so arranged that the movement of the top block forward reduces the cut-off in that half of the cylinder supplying heating steam, and the simultaneous movement of the bottom block in the opposite direction increases the cut-off on the power side of the cylinder. By this means the quantity of steam which is exhausted to the heating main is kept constant—unless it is varied by hand—and the balance of steam required to meet the load on the engine is exhausted to the condenser in the most economical manner.

The action of the governing gear will be clearly seen from the series of indicator diagrams reproduced in Fig. 9. The set of indicator cards here shown were taken from an engine of the type we have just described, and it will be noted that the cut-offs vary considerably in the two halves of the cylinder as the demand for exhaust steam changes. The cards marked B are taken from that half of the cylinder which is working against back pressure, and is delivering steam to the heating main, and those marked C are taken from the half of the cylinder which is working on the condenser. The horsepower developed by the engine is approximately the same in each of the three cases. Attention may be called to the bottom left-hand card, which represents the conditions obtaining in the back-pressure side of the engine cylinder when working with a very small cut-off. Even under these unfavorable conditions practically no loop is shown. This result is made possible by the specially designed exhaust valve which we have previously referred to and which is shown in detail in Fig. 2. The feature of this valve is that a series of non-return valves are placed close against the main exhaust valve, and in this way the steam is prevented from getting back into the cylinder. A marked improvement in working is shown if the two lower cards marked B are compared with card A, which was taken from the same engine working with the exhaust valves of the old design. With the old design of valve the loop is very marked, and the resulting loss considerable.

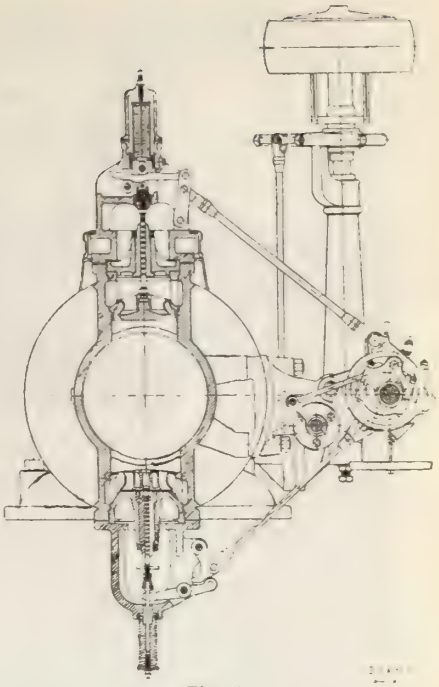


Fig. 4.

Log of a Trial Run

The maximum back pressure against which a passout engine is capable of working is fixed by the initial steam pressure, and engines are generally built for back pressures varying from 7 lb. to 50 lb. per square inch pressure. For a back pressure of 50 lb. per square inch an initial pressure of 160 lb. to 170 lb. per square inch is required. The steam consumption varies according to the sizes of the engines and the conditions under which they have to work. As an example we give the following report of the final tests of a 280 indicated horse-power Atlas one-cylinder type pass-out steam engine, which was recently installed at the Soda Works, Limited, Copenhagen.

GENERAL PARTICULARS

Diameter of cylinder..... 19.75 in.

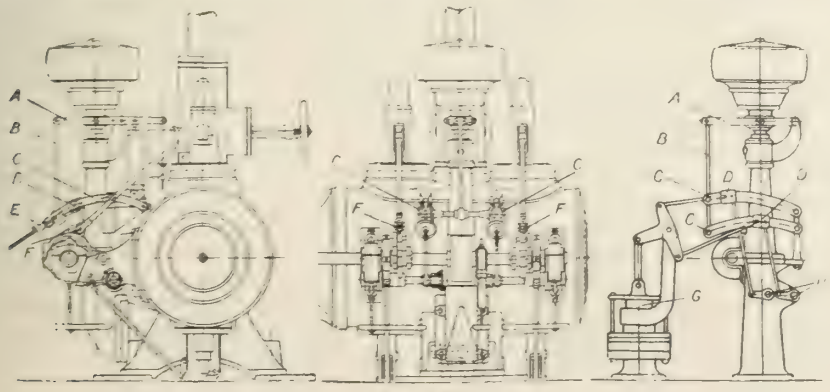


Fig. 5-6-7.

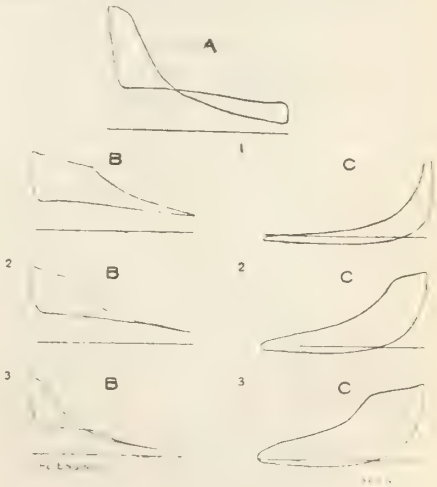


Fig. 9.

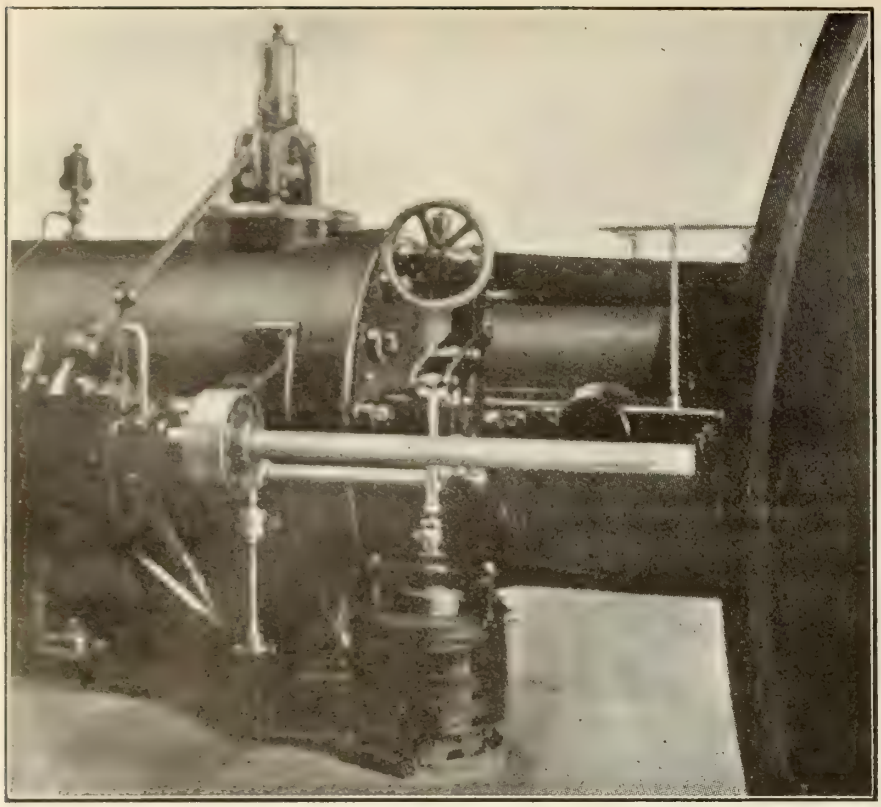


Fig. 8

Stroke	27.5 in.
Speed	150 r.p.m.
Normal load	280 I.H.P.
Maximum continuous load	375 I.H.P.
Boiler pressure	145 lb. per sq. in.
Total steam temperature at engine stop valve	605 deg. Fah.
Type of condenser	Jet condenser
Temperature of cooling water	70 deg. Fahr.
Vacuum average with barometer at 30 in.	26 in.
Pass-out steam pressure	42.5 lb. per sq. in.

The following steam consumptions were guaranteed:—

	Full load	Three-quarter load	Half load
Pass-out cylinder half, pounds, per I.H.P.-hour	35	37	43
Condensing cylinder half, pounds per I.H.P.-hour	12.8	12.8	13.6

The mechanical efficiencies were:—At full load, 92 per cent.; at three-quarter load, 89 per cent.; and at half load, 84 per cent. The engine was designed so that under normal conditions the front half of the cylinder works condensing and the back half of the cylinder against a back pressure of 42½ lb. per square inch. As we have already described the load on the two cylinder halves is regulated by a steam-pressure governor operating on the eccentric gears, and controlling through these the inlet valves, so that by varying the cut-off the exact quantity of steam required for heating purposes is admitted to the cylinder half working with back pressure, and the balance of power required is developed by the half of the cylinder which is working condensing.

For the purpose of testing the engine, two trials, each of approximately four hours' duration, were run, the first one with both cylinder halves working condensing and the second with both cylinder halves working against back pressure. We append particulars and results of these two tests.

Test I.

Boiler pressure	128 lb. per sq. in.
Pressure at engine stop valve	126 lb. per sq. in.
Total steam temperature	575 deg. Fah.
Temperature of cooling water	70 deg. Fah.
Vacuum (barometer 29½in.)	25.25 in.
Speed	146.4 r.p.m.
Indicated horse-power	197.2
Total steam consumption, per hr	2,160 lb.
Steam consumption per I.H.P.-hour	13.2 lb.
Steam consumption per I.H.P. hour, corrected for 145 lb. boiler pressure and 605 deg. Fah. steam temperature	12.8 lb.

Test II.

Boiler pressure	124 lb. per sq. in.
Pressure at engine stop valve	120 lb. per sq. in.
Total steam temperature	577 deg. Fah.
Back pressure	42.5 lb. per sq. in.
Speed	143.9 r.p.m.
Indicated horse-power	155.0
Total steam consumption per hr.	6100 lb.
Steam consumption per I.H.P-hr.	39.4 lb.
Steam consumption per I.H.P.-hour, corrected for 145 lb. boiler pressure and 605 deg. Fah. steam temperature	34.4 lb.

We show in Fig. 8 an illustration of a 750 brake horse-power single-cylinder pass-out engine working in a large brewery.

A HANDY REPAIR

The following little experience may be of use to some other engineer in a similar case, and is given for what it is worth.

A cross compound Corliss engine had just been installed, and had run its preliminary trials, when a part of the joint of the low pressure head at the crank end blew out. To remove the head and make a complete new joint would have meant a lot of work, besides running the risk of throwing everything out of alignment again. The following plan was therefore adopted.

Litharge and glycerine were pumped in around the bolt hole where the joint had given out, by means of a force pump. This was allowed to set, and the job again put into operation, when it was found the joint was tight and satisfactory in every way, and the engine is running at present with that repair.

HOLIDAY BOILER CLEANING

By "Jimmie"

A subject which should be of interest to owners, superintendents, managers, etc., as well as the engineer, is the question about the time-set boilers. I refer particularly to the small plant containing only two or three boilers. I believe it will be admitted that cleaning is often set for a public holiday, the owners, or whoever has the fixing of the time, think they are saving a day by following out this dangerous practice. It can be dangerous as it is certainly very bad business under certain conditions. Sunday cleaning is bad enough considering the practical side of the question only as the firing can be discontinued at noon Saturday and the boiler and brickwork will have a chance to cool down considerably by Sunday morning and there are big chances that the average engineer or cleaner will do an honest job even if his inclination is against Sunday work. But when a fire is kept going until the evening preceding a holiday and the boiler cleaned out on the holiday, it is very often cleaned in name only. A boiler cleaned in a hurry by a discontented man is not cleaned at all as a rule. I believe the boilers in a plant where the public holiday cleaning act is in force will soon acquire a pretty thick coat of scale or worse. Neglecting to consider the question of fuel waste there is the danger of burned plates and the impossibility of noting defects such as pitting, etc. The cost of the fuel waste in such a condition even when there is only one or two boilers would, in a few years, pay the cost of a new boiler and for the installation of it. How can an inspector give an unqualified report of a boiler's condition in a case of this kind? About the only thing he can be certain about is the coating of scale. Really necessary repairs are often ignored in plants where the boilers are only out of service on public holidays and if the repairs are attempted at all they are done in an inefficient, hurry-up way because the men are eager to get away. Holiday cleaning like holiday inspecting is never as satisfactory as when done at other times. The discomfort of boiler cleaning and inspecting is great at any time, these discomforts are usually accentuated on the public holiday plan on account of the great heat and if preparing for the inspector the external cleaning as well as the internal is apt to be hurried and imperfect. If the inspecting is done on the holiday nobody may be at hand should the inspector require service. Much more could be written against this public holiday habit but I think a little consideration will convince most folk that boiler cleaning and boiler inspection should never be hurried under ordinary conditions. Either job is likely to be a hurry-up one when done on a week day holiday.

Overcoming Heavy Costs of Belt Maintenance

Transmission Problems Should be in Charge of Competent Man —Inspection Should be Made Regularly—Importance of Proper Alignment—Lacing of Joints Should Be Carefully Performed

By J. H. RODGERS

ECONOMICAL production under modern competitive conditions is largely a matter of getting the most out of plant and equipment. Machinery, tools and appliances are for the most part carefully purchased and industriously kept in good working order after installation, yet in mills where the greatest care is exercised in the constant maintenance of machinery, little or no attention is paid to the upkeep of transmission belting. The result is a loss in power and production so serious that it frequently causes a very appreciable loss in profits. Satisfactory operation of any system of mechanical power transmission depends upon the care with which the belting equipment is selected and cared for after installation. Yet so general is the efficiency in most mills that the extent of loss in production through this item is seldom realized.

Saving Power Wasted

The power that is produced is that actually delivered to the machine pulley—and the power that is costly is that which is lost somewhere between the boiler and the belt on the driven pulley. Much of this wasted power can easily be saved by constant, careful attention to the upkeep of the transmission system. A good share of power loss is caused by neglecting to keep belting in first-class condition; by failure to tighten loose belts, to dress dry belts and to repair worn-out belts. Part of this failure is due to the fact that the loss is not often recognized by mill superintendents and master mechanics. The greater part, however, is due to the fact that anyone in the average mill looks after the belts on his own machine or in his own room.

No one would think of running a mill without a competent man to take charge of and repair machinery. Why then expect the belting on which those same machines are directly dependent to operate with little or no skilled attention? The first move to cut down transmission costs, reduce power losses and eliminate break-downs should be the placing of one man (on each shift, if necessary) in complete charge of all transmission equipment—shafting, pulleys, hangers and belting. Put him in absolute control and hold him to the responsibility. Allow no installation changes, repairs, or dressings except by him or under his direction. This arrangement is advisable for two reasons. First it insures the equipment of constant attention so that repairs are made when needed and not two weeks later as is often the case. A stitch in time is particularly true in the case of belting. Then second, it ensures, so far as may be, uniform treatment of the belting—a very desirable factor in increasing belt- life and in lessening the chances of breakdowns and loss production.

Experienced Supervisors Necessary

When possible, it is desirable to put an experienced man on the job, but where this is impossible, a man should be selected and given a short course of training in a belt factory, where he will learn how to make laps, take up belts, repair and dress belts, etc. A week or ten days in any good belt shop will go a great way toward transmission efficiency in the mill. Most belt manufacturers are glad to allow a man to spend this time in the factory, learning the rudiments of belt making. A mill should be provided with the necessary equipment for doing all ordinary belt work—breakdowns and tie-ups are too frequent and too expensive to depend on outside repairs. The tools ordinarily required are clamps and rods (for holding belt when cementing endless), belt scraper, belt shave, slicker, spoke shave, hand punch (for lacing holes), cement, brush, and kettle for melting the glue. These tools can be supplied for a reasonable amount from any mill supply dealer or belt manufacturer.

Regular Inspections Needed

After placing your belt man in charge, see that he makes a regular inspection of every belt in the mill at least every two weeks. This systematic inspection should cover such points as general conditions of belt, need of dressing or of cleaning, tension, condition of laps and joints, amount of belt slip, amount of wear, etc. Pulleys and shafting should be carefully watched to see that they are in strict alignment. In many mills it has been the practice to have regular reports made of such inspection—but this does not always pay, except in the case of large mills with hundreds of drives. Experience has proved that constant, systematic inspection of all shafts, belts and pulleys, by a competent man, followed up by prompt attention to all necessary repairs, will reduce belting bills from 10 to 20 per cent. while practically eliminating any unexpected delay through faulty power transmission. All trouble with the belting in the plant should be immediately reported to the belt man, and he should be held responsible for the continuous operations of every machine in the mill.

The second point in economical operation of a power transmission system is the standardization of belting for each drive. This merely means that

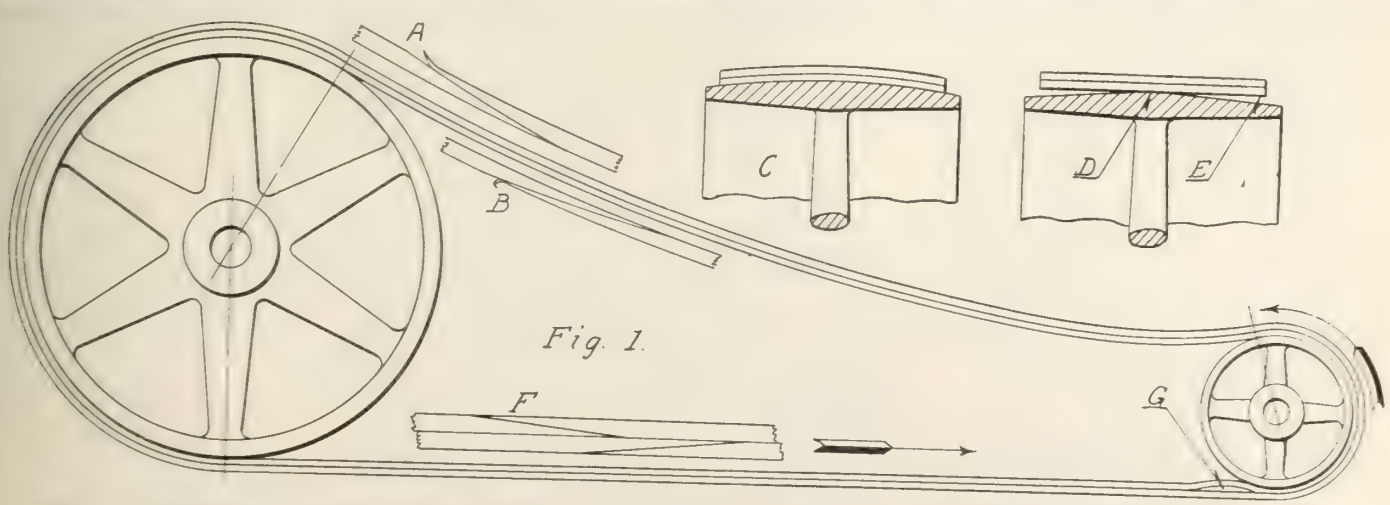


Fig. 1.

Fig. 1.—A. Thin edge of cap curling from air pressure. B. Curl from pulley contact. C. proper method of crowning pulley. D. Avoid sharp crown. G. Ply lifting due to creep.

for every drive there is one type, brand, ply, width and weight that will work out most efficiently. Find out as nearly as possible what that belt is—and order it for that drive when necessary. The standardizing if applied with a fair measure of common sense and not carried to extremes, will amply repay the time and effort spent on it.

Belting should be purchased with the due regard to the mechanical and physical condition of the drive. The main things to keep in mind when ordering belting are; diameters, faces and speeds of pulleys, type of drive (open, crossed, vertical, etc.,) centre distance between pulleys, load to be carried, and the atmospheric conditions (dust, steam, fumes, etc). Pulley diameters control the weight or thickness of the belt to be used; belt speed controls the power that can be transmitted by the belt; load to be carried determines belt width; type of drive and physical condition determine the type of belting best suited.

Nor is it always necessary to specify first-quality belting of any particular type. Where the work is light or the pulley large or the speed low, second quality belt can often be used with just as satisfactory results as higher priced brands. When the best type, ply, width and weight for any drive have been determined by the belt man, make a record of it for the use of the purchasing department or for the superintendent. Always specify the standard instead of "using what you have left over" from other work—it pays better.

Proper Tension

The third item to watch out for is belt tension. The tightness with which belts are put on pulleys is of prime importance. If a belt is too tight, there is a large loss of power from excessive friction at the bearings, to say nothing of the fact that the belt itself is overstrained and weakened. On the other hand, if a belt is too loose, it is liable to flop around and jump from the pulley, particularly when working where a load is suddenly thrown on or off. If too loose, there is sure to be unnecessary slip and loss of power as well. When belts are installed and taken care of by one man, the errors of too tight and too slack belting should be avoided and a uniformity of tension will result, which could not be secured as easily in any other way.

Aligning Shafts and Pulleys

Fig. 2 shows a simple method of lining up two pulleys. The operator, with a helper, takes a piece of cord and stretches it from the outside edges of the two pulleys just above the shaft or hubs if the latter extend beyond the edge. With this method it is understood that the shafts have been lined up previously and that the pulleys run true. When using the string it is well to try the pulley in several positions to allow for any irregularity in run of the pulley.

Crowning of Pulleys Important

Steady running of belt is essential to effective transmission. For continuous drives, belts are generally run on pulleys that are very little wider than the belt, and to maintain its position in the centre, the pulleys are invariably crowned. This crowning usually consists of two straight tapers meeting at the centre of the pulley face. The amount of the taper varies from ⅛ to ¼ inch per foot; that is, a pulley 12 inches wide would be about 1-16 inch larger in diameter in the centre than it would be at either edge. In a straight taper crown, however, it will be seen that the apex D, Fig. 1, forms a definite or pronounced breaking point; nothing very serious possibly, but with a tendency, especially in new and heavy belts, to provide an air space at the edges E. A better plan of pulley crowning is that shown at C, where the surface forms an arc; this method equalizes the bending stresses throughout the width of the belt and makes the surface contact more uniform.

Preparing Belt For Lacing

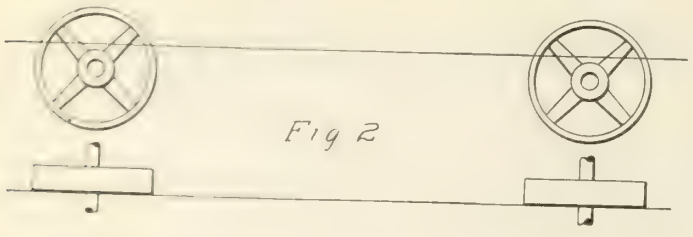
One of the essential factors of a belt joint is that the ends should be perfectly square with the run of the belt, to assure its smooth running. When cutting a belt the use of a try square, as shown at A, Fig. 7, is always advisable. Without such a tool the tendency is to make an angular cut as at the right, so that when the joint is made it has the appearance as illustrated at B. When passing over a pulley the belt develops a tendency to oscillate, and such a condition is very much aggravated when the belt is running a little loose. To prevent it jumping off, a stick is frequently secured to some rigid support and extended down at the side of the pulley. This, however, provides only a temporary remedy for a previous fault, as the weakest portion of the belt—the laced joint—is continually brought into violent contact with this "guide" and eventually the efficiency of the drive is destroyed.

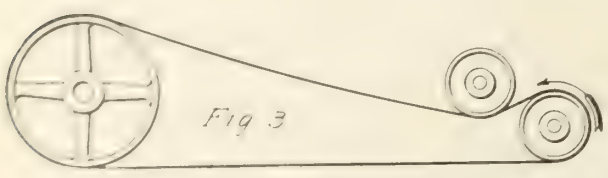
Making a Laced Joint

In making a joint it is advisable to use a thin lace in preference to a thick one. This coincides with what has been said on belt contact, as it is clear that the thicker a lace is the less will the contact be when the joint is passing around the pulley, and in addition the jar will be all the more pronounced. When making a joint the straight lacing should be made on the pulley side. Owing to the different widths of belts no fixed rule can be applied for lacing, but in general the method may be the same for every case. Holes should not be closer to the edge or end than one-half inch, with centre holes spaced accordingly. The best practice is to commence at the centre and work out and back on each side. As a guide the illustration Fig. 4 is given. Starting at 0 and 1 the order is as follows: 2, 3, 4, 5, 4, 3, 2, 1 or 0, both sides of the centre being identical; the locking is performed by passing the free end through a small hole 6, and cutting a short slit to form a hook that will prevent the lace from coming out. This lock should be on the outside of the belt. After the joint is made it may be lightly hammered down with a wooden mallet.

Use Small Lace Holes

It must not be taken for granted, however, that all one has to do is to cut off a piece, punch a few holes and secure again with a lace, to obtain an effective drive. The fundamental details of a properly made joint may often seem of little import, but the subsequent





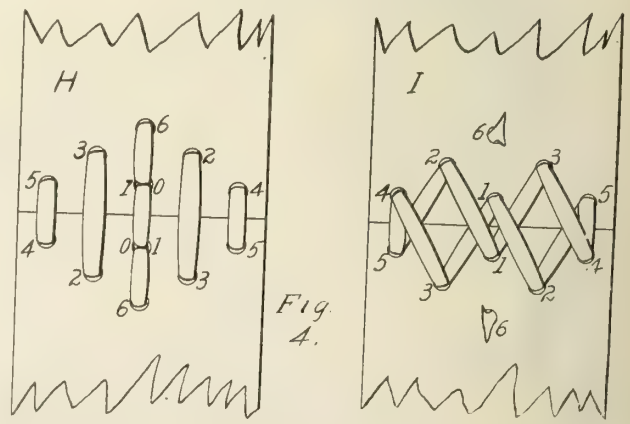


Fig. 2.—Aligning pulleys with string. Fig. 3.—Position of idler. Fig. 4.—Showing effective method of lacing belt, straight lacing on pulley side.

operation of the belt may depend, very largely on the consideration given to these apparently insignificant matters. When making a repair to a belt the beginner will usually make the lace holes of large size as indicated at centre of Fig. 5. The inevitable consequence of such practice will be that shown below at the left. With very few exceptions, a belt will tear across the lace holes and seldom will fail in a direction parallel to the belt length. For this reason it is imperative that the amount of the leather cut be kept as low as possible, consistent with the size of the belt and the thickness and width of the lace. Where it is necessary to enlarge the holes it should be done as shown at the right. This is obvious when comparing the resultant efficiency of the belt in each case. The short light space indicates the portion of the width cut away by the holes and the dark portion the effective section of the belt.

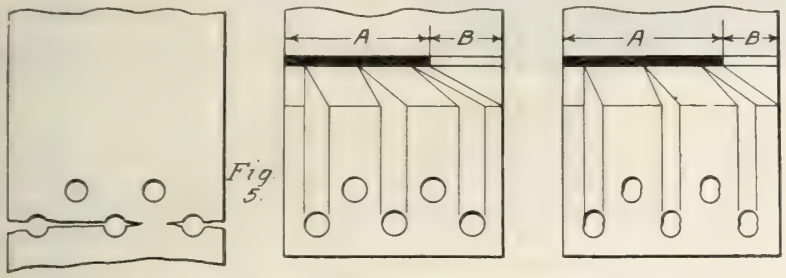


Fig. 5.—Effect of having lace holes too large.

The best side of the belt to run upon the pulley appears to be a debatable question, as many favor the hair or smooth side, while others prefer the reverse. However, as the efficiency of a belt drive relies on the frictional contact between the surfaces it would seem practical that the smooth side would have the preference. Another factor in its favor is that of the recognized fact that the portion of the belt best suited for tensile strength is near the flesh or rough side, and the hardest side best adapted for the compression action; these features being quite evident when belts are operating on small pulleys.

It is evident that the slacker a belt can be run, up to a certain point, and do its work satisfactorily, the greater the economy. In installing belting and in taking it up, consideration must be given to the fact that certain kinds of belting are affected by atmospheric conditions, lengthening and shortening according to the amounts of moisture in the air. Water-proof leather belting, properly made, does not stretch much even when working in moist air for a long period. The best tension at which to operate a belt is that at which the belt will carry its load easily without straining and with a minimum of journal friction. Operate all belts just as slack as possible without slipping. When it is necessary to operate a leather belt tight on a drive to carry the load, that is a sure indication that there is something wrong with the drive which should be investigated and remedied.

High Tension

With an intermittent load, or one which varies greatly, it may be necessary to instal and operate belts at high tension. Bearings and shafting of course play a part in the amount of tension which can economically be used. For example, a belt can be installed with a greater tension on a self-aligning bearing than on a rigid pillow-block bearing. Again, a belt can be installed at a greater tension of a 23/16 in. shaft than on a 15/16 in. shaft. Belts which operate under a heavy load or which are travelling at high speed, usually require taking up every six months or so. Failure to do this means great waste of power through belt slip. When a belt runs suddenly to one side, after running straight for some time, it may be laid to sudden overload, or belt too loose. It may be necessary to reduce the load and tighten the belt. Where the required tension cannot be secured normally, idlers are used, both to increase the arc of contact, and to increase the tension. See Fig. 3.

Fourth: Eliminate injurious dressings and use a little good dressing sparingly. This is perhaps the most neglected item in the care of belting—and one of the most important. Belt dressing is necessary either when a belt is slipping badly for no apparent reason or when in the case of leather belting the natural oils have dried out of the leather, leaving the belt dry and harsh.

(To be continued)

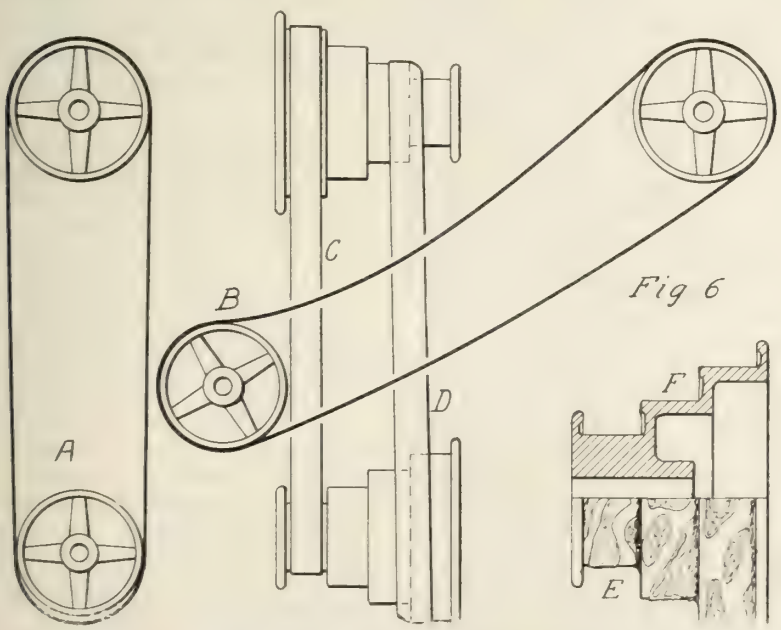


Fig. 6.—Vertical belts must be kept tight. D shows a serious fault on cone drive. E shows abnormal use of belt dressing.

RILEY INTERESTS ACQUIRE UNDERFEED STOKER CO.

The Sanford Riley Stoker Co., Ltd., Worcester, Mass., has acquired control of the stock of the Underfeed Stoker Co. of America, Detroit, and its subsidiary companies, the A. W. Cash Co., Decatur, Ill., the Craig Damper Regulator Co., Detroit, the Underfeed Stoker Co., Ltd., of Canada, the Craig Damper Regulator Co. of Canada, and the A. W. Cash Co., of Canada, Ltd. The Underfeed Stoker Co. is the oldest manufacturer of underfeed stokers for power boilers.

R. Sanford Riley, President of the Sanford Riley Stoker Co., becomes president of the Underfeed Stoker Co., and its subsidiaries. S. A. Armstrong, Detroit, will continue as vice president and managing director of the Underfeed company. By the consolidation Mr. Riley becomes president of nine companies, the five acquired in the merger, together with the Sanford Riley Stoker Co., the Sanford Riley Stoker Co. of Canada Ltd., the Murphy Iron Works and Murphy Iron Works Co. of Canada, Ltd.

The capital stock of the Riley company is $1,250,000 which, together with the $1,000,000 of the Underfeed company, makes a total of $2,250,000.

Headquarters of the merged companies will be in Worcester. The product of the Underfeed Co. will hereafter be manufactured at the plant of the Murphy Iron Works, the Detroit branch of the Riley company. The Cash company makes valves and valve specialties and also at these works is produced the Craig Damper regulator.

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The Inter-Provincial Boiler Law

THE INTER-PROVINCIAL boiler code is now a fact, and is in use in the larger number of the provinces of the Dominion. The regulations have been set out in book form, and are now available to the public, at a price of $1 per copy.

It is interesting to note, that the first conference held at which representatives of the different provincial governments were present, to consider a uniform law, was as far back as 1909. The provinces represented on that occasion were British Columbia, Alberta, Saskatchewan, Manitoba and Ontario. The regulations drawn up at that conference were adopted by the provinces of Alberta, Saskatchewan and Ontario.

The regulations then adopted, while good in their way, were not comprehensive enough, and left many points uncovered, so that there naturally arose differences of interpretation. Owing to this, a further conference was held in Ontario in 1914, at which the regulations were revised and amendments recommended, but owing to the outbreak of war, and the general disorganization which followed, these recommendations were not officially adopted.

Nothing more was done until 1918, when a further meeting of the interested provinces was held in the Manitoba provincial buildings, at which the whole question was thoroughly gone into, and consideration given to suggestions which had been put forward by manufacturers, boiler makers, etc. The regulations as drawn up at this meeting were submitted to the Boiler Code Committee of the Engineering Institute of Canada, the Canadian Manufacturers' Association, and others for criticism. After this, a meeting was held in New Westminster in 1920, at which final revision of the code was made after studying the reports received. It will thus be seen that from the time of the first consideration of this question until its final adoption a period of thirteen years has elapsed. Of course, there is no doubt that the war threw things back to some extent, but in any case, it is evident that at least eight or nine years would have been consumed in effecting this very desirable reform.

It is an excellent thing from the point of view of the boiler manufacturer, and also of the boiler purchaser. It ensures the manufacturer the opportunity of building a boiler that will comply with the regulations in any province, while the purchaser has no fear of buying a boiler in Ontario that will not pass inspection in Manitoba, or vice versa. The regulations adopted have also provided for the use of boiler material which has been made to the specifications of the British Board of Trade, so that a manufacturer importing his plates, or a firm importing boilers from Great Britain will not be penalized.

Practically every province with the exception of New Brunswick and Prince Edward Island have adopted these regulations, and it will most likely be but a short time until they are in force in these latter provinces. The advantages of uniformity are too many for them to be neglected by any modern government department or private business concern.

* * * *

The Pass Out Engine

IN ANOTHER part of this issue of "Power House" will be found a description of an engine being manufactured in Europe, which has some points that should make it of interest to steam users in this country. The engine has been designed to fulfill the dual purpose of supplying power and heat, such as engines are doing all over Canada every day, but in this case, there is a more elaborate arrangement than the simple weighted back pressure valve to keep a required pressure in the heating mains.

Briefly, the design is such that while one side of the piston is operated by steam exhausting to a condenser in the ordinary manner, the other side of the piston is connected to the heating mains. On the latter side control is effected by a governor operated from the pressure in the heating mains, and so arranged that if there is a demand for more steam in these mains, the cut off is lengthened on the side which is in communication with them, and shortened on the side in communication with the condenser which thus makes the total power the same.

It has been found that with this type of engine very economical working can be obtained where the power load is so much less than the heating load. These engines are made in sizes to 1,000 h.p. in one cylinder, thus making a compact arrangement.

The high cost of fuel in the districts where this engine is in use was the immediate cause of its adoption, and we should think there are many places in this country where something of the same kind could be used to advantage. We have the high cost of fuel with us, we have also the necessity for heat during a large portion of the year, and for process work during the whole of the year. There are many firms still buying electric power and burning fuel for heat at the same time. It is only in exceptional cases that there is any real saving in following this course. Even with the ordinary relief back pressure valve method of heating, or the bleeder turbine, power and heat can be obtained from practically the same amount of fuel as heat alone requires. With an engine built along the lines described still better results should be obtained than are now possible.

Progress in New Equipment

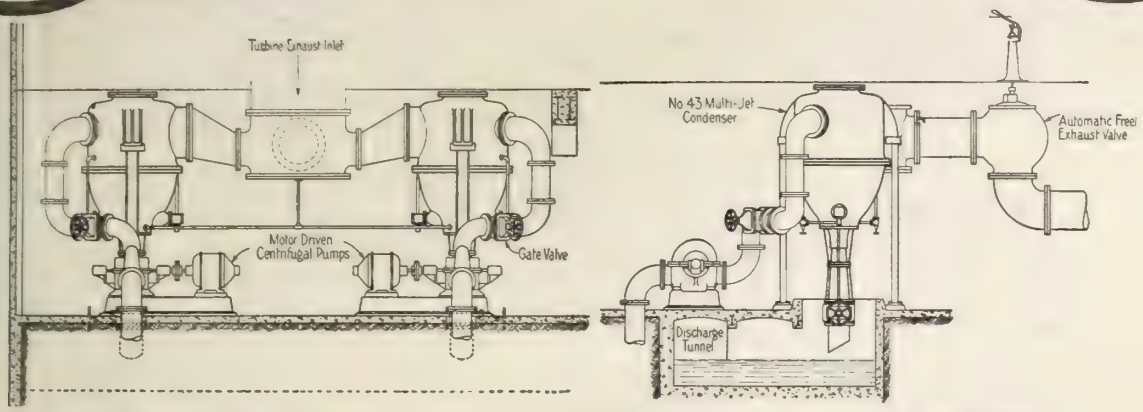


Fig. 1. Diagrammatic arrangement of the twin low-level multi-jet condenser installation at the Baltimore Consolidated Gas, Electric Light & Power Company.

A TYPICAL LOW LEVEL MULTI-JET CONDENSER INSTALLATION FOR CENTRAL STATION SERVICE

By A. L. Penniman*

IN JANUARY, 1921, the Consolidated Gas, Electric Light & Power Company, of Baltimore, installed two No. 43 Schutte & Koerting low-level multi-jet condensers to serve a 9,000 K. W. General Electric turbine.

A most interesting feature of this twin jet condenser installation is its simplicity. The customary removal and air pumps are dispensed with—the air non-condensable gases and water being removed from the condenser by the cooling water on the ejector principle. The only pumps required are two standard motor-driven centrifugal Cameron pumps** for supplying the injection water to the condensers. A plan and elevation of the installation are given in Fig. 1.

The manufacturer's guarantee was 28.25 inches vacuum referred to a 30-inch barometer at full load with 70 deg. F. injection water. In the acceptance test, the guarantee specified was exceeded by 0.08 inches. Because of the value of the test results obtained and their significance as to what can be expected of jet condensers of this type under the conditions existing in central station service, the test referred to is given in detail.

A sectional elevation of the low-level multi-jet condenser is shown in Fig. 2. It consists of a condenser body or closed cylindrical chamber, the upper end of which contains a water nozzle case, below which is fitted a combining tube consisting of several sets of tapering rings joined together by equally spaced ribs. The combining tube is connected to a tail diffuser discharging into a hot well underneath.

The water nozzle case is provided with a nozzle plate containing the water nozzles. The injection water is supplied to the condensers under a pressure of about 10 lbs. per sq. in., corresponding to a 23 ft. head, and discharged through the water nozzles, which are designed to pass a specified amount of water depending upon the conditions of flow determined by the water pressure and the existing vacuum. As the water jets emerge from the nozzles, they are directed into the throat of the combining tube, where they unite to form a single jet. The exhaust steam enters the condenser chamber through the exhaust steam inlet, flows through the annular passages between the tapering rings, comes into direct contact with the converging water jets and is condensed. Because of the combined effect of the external water pressure, the vacuum existing in the condenser, and gravity, the multiple water jets attain a velocity which is sufficient to entrain the condensed steam, air and non-condensable gases, and to discharge them into the hot well against the pressure of the atmosphere. The water jets create the vacuum by condensing the steam, and maintain the vacuum by entraining and removing the air and non-condensable gases.

The energy of the water jets is sufficient to overcome the friction and back pressure in the tail diffuser, wherein the velocity head of the water is converted into a pressure head that is large enough to overcome the atmospheric pressure.

This type of condenser does not depend upon the vacuum produced for its supply of injection water. In most jet condensers, where the injection water is drawn into the condenser by means of

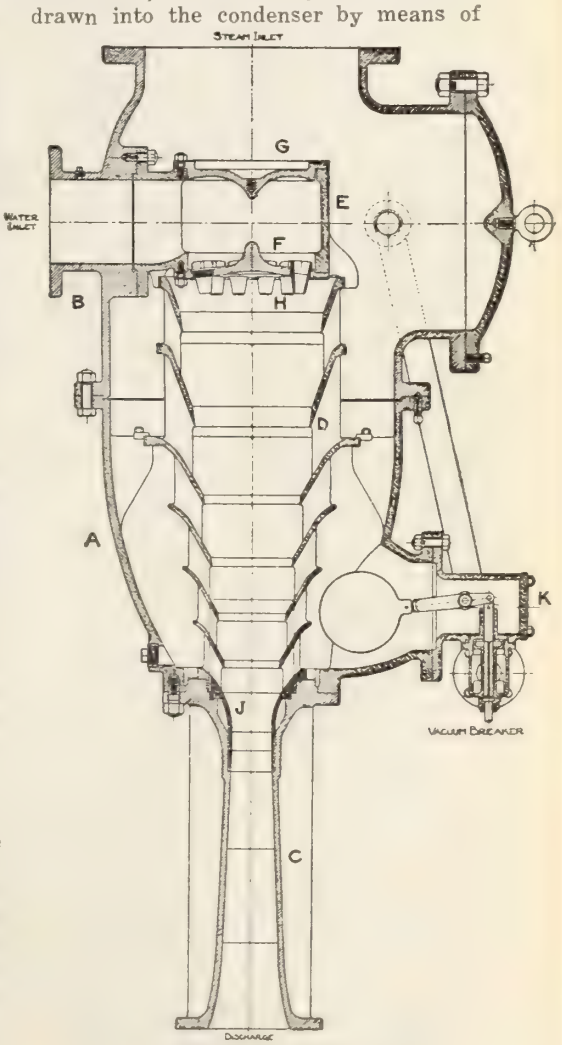


Fig. 2. Sectional elevation of the low-level multi-jet condenser.

*Superintendent of Steam Stations, Consolidated Gas, Electric Light & Power Co., Baltimore.

**Both the pumps and the condensers by the Ingersoll Rand Co., N. Y.

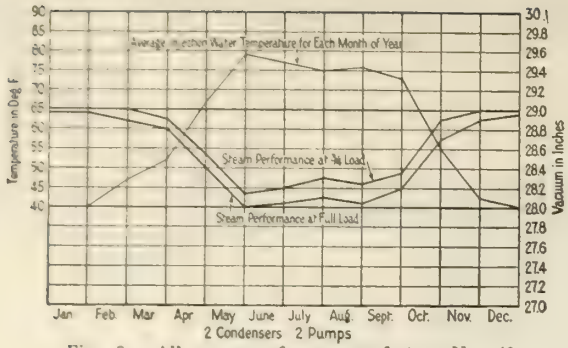

Average Injection Water Temperature for Each Month of Year
Steam Performance at ¾ Load
Steam Performance at Full Load
Temperature in Deg. F
Vacuum in Inches
Jan Feb Mar Apr May June July Aug. Sept. Oct. Nov. Dec.
2 Condensers 2 Pumps

Fig. 3. All year performance of two No. 43 multi-jet condensers under three-quarters and under full load conditions.

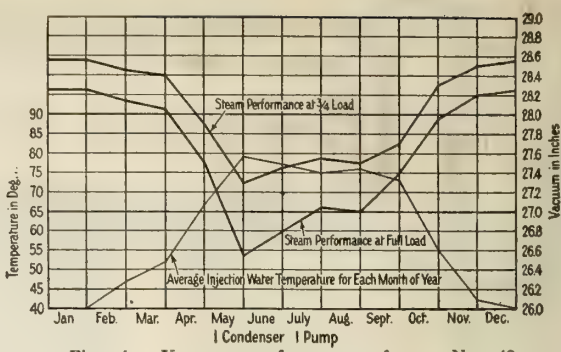

Steam Performance at ¾ Load
Steam Performance at Full Load
Average Injection Water Temperature for Each Month of Year
Temperature in Deg.
Vacuum in Inches
Jan Feb Mar Apr May June July Aug. Sept. Oct. Nov. Dec.
1 Condenser 1 Pump

Fig. 4. Vacuum performance of one No. 43 multi-jet condenser under full load and three-quarters load.

the vacuum created therein, the supply of water decreases with the vacuum at periods when sudden overloads are thrown on the turbine, because the water flow varies directly as the difference between the vacuum in the condenser chamber and that in the suction lift. In other words, when there is the greatest demand for condenser cooling water, the supply available is the least. The low-level multi-jet condenser, however, avoids this difficulty and is therefore adapted for plants where the suction lift of the water is considerable and where the power demand fluctuates, as in electric railway power plants, central light and power plants, etc., etc.

The multi-jet condenser requires a greater water-to-steam ratio per lb. of steam condensed than other low-level types, because the water accomplishes the removal of both water and air from the condenser. Nevertheless the total power to operate the multi-jet compares favorably with the power required by other jet condensers. This is so because the pump supplying the injection water operates under conditions favorable to centrifugal pumps, that is, under a low suction head, and thus the maximum pump efficiency is obtained.

Fig. 3 gives the all-year performance of the two No. 43 multi-jet condensers under three-quarters load and under full load conditions—corresponding to 84,000 and 112,000 lbs. of steam per hr. respectively. As shown by the figure, at no time does the vacuum fall below 28 in., even in summer, when the temperature of the injection water is as high as 78 deg. F.

The accompanying table itemizes the performance test data referred to above. Particular attention is directed to the vacuum obtained, 28.33 in. referred to a 30-in. barometer. This is 0.08-in. above the vacuum 28.25 in. guaranteed by the manufacturer for 70 deg. F. cooling water. During the test the temperature was nearly 1 deg. F. higher, or 71 deg. F.

TEST ON NO. 6 CONDENSERS

Average Load of Unit, K.W.	7450
[illegible] at Throttle, Lbs. Gage	177.9
[illegible] at Throttle, Deg. Fahr.	477.5
[illegible] In. of Mercury	30.04
Vacuum On Condenser, Referred to 30 in. Barometer	28.33
Absolute Pressure In Condenser, In. of Mercury	1.67

CONDENSER 6A.

Injection Water Pressure At Inlet, Lbs. Per Sq. In.	10.4
Injection Water G.P.M. (Calculated From Pressure In Nozzles)	10,312
Injection Water Temperature, Deg. Fahr.	70.7
Temperature Of Water Discharged, Deg. Fahr.	81.4
Temperature Rise of Injection Water, Deg. Fahr.	10.7
Steam Condensed, Lbs. Per. Hr. (Calculated From S=GPM x (T2 - T1). 2	55,169
Water to Steam Ratio	93.5

CONDENSER 6B.

Injection Water Pressure At Inlet, Lbs. Per Sq. In.	10.2
Injection Water G.P.M. (Calculated From Pressure In Nozzles)	10,273
Injection Water Temperature, Deg. Fahr.	71.0
Temperature of Water Discharged, Deg. Fahr.	80.6
Temperature Rise of Injection Water, Deg. Fahr.	9.6
Steam Condensed, Lbs. Per Hr. (Calculated As For 6A)	49,310
Water To Steam Ratio	104
Total Steam Condensed, Lbs. Per Hr. (Calculated From S=GPM x (T2-T1) 2	104,479
Total Steam By Flow Meter, Lbs. Per Hour	111,246
Total Injection Water, G.P.M.	20,585
Water To Steam Ratio Overall	92.5
Water Rate of Turbine, Lbs. Per KWH. (Using Flow Meter Reading)	14.95

Overall water to steam ratio and water rate are figured from flow meter readings.

G.P.M. are calculated from pressure on condenser nozzles.

Vacuum of—28.25 in. should have been obtained based on curve submitted.

Vacuum of—28.33 in. actually obtained.

0.08 in. amount in excess of guarantee.

The evident advantage of the twin condenser arrangement is greater flexibility and greater reliability. It is possible to shut down one unit and to operate with one condenser and one injection pump only during periods of light load or during the cold season. Thus a spare unit is available at all times in case one of the condensers or pumps has to be shut down for overhauling, in an emergency, etc.

The fact that the water is supplied by pumps external to the condensers and that the continuous water supply is entirely independent of the vacuum in the condensers removes the two greatest objections to the ordinary type of low level jet condensers—thereby greatly increasing the reliability of the unit and materially lowering the maintenance costs and the time out of service for repairs.

In the twin arrangement, the tail pipes of both condensers are equipped with gate valves in the discharge. When the gate valve of the idle condenser is closed, the possibility of flooding this condenser is eliminated, and any water that may seep through from the hot well, due to the suction effect of the vacuum, is drained off into the operating condenser by means of an equalizing pipe connecting the two condenser chambers directly above the tail throat. This equalizing line also takes care of any condensation that may collect in the idle condenser.

The vacuum performance of one condenser with full load and three-quarter load, and with various water temperatures is shown in Fig. 4.

NEW HAND TACHOMETER

The hand tachometer illustrated has many distinctive features which will appeal to manufacturers who are endeavoring to increase production. And there are plenty of plants which could benefit by the use of such an instrument, judging from a report recently made public by the Elimination of Waste in Industry Committee of the American Engineering Council, which gave as one of the principal reasons for low production the fact that a large percentage of the manufacturers are operating at approximately 50 per cent efficiency.

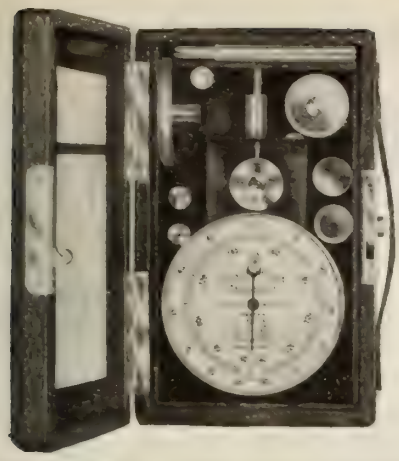
This new tachometer is most compact. It fits the hand conveniently and weighs only 13 ozs. Consequently it should not tire the hand even with long continuous use. Complete with Morocco carrying case and couplings the weight is only 1 lb. 10½ ozs.

It has an exceptionally wide range, being furnished in two standard speed ranges, one 20 to 8,000 and another 40 to 16,000 each with five intermediate ranges which cover every speed met with in industrial practice. This gives approximately 20 inches of effective length to the scale.

Each dial is graduated individually by hand from a master tachometer and covered by a convex glass. Graduations and subdividing lines are engraved on a 3 inch ivory finished dial, making it easy to read.

The oiling system which is patented, provides for three months' supply of lubricant. Felt wicks act as filters, preventing foreign matter from reaching the bearings.

The ball closed opening of reservoir keeps out dust and dirt. The case is also said to be dust-proof, thus pre-



venting foreign matter from entering the inner works and causing wear and deterioration.

This hand tachometer is an addition to the line of Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y., and is marketed under the name of "Columbia."

ARMATURE TESTING DEVICE

An armature testing device has just been placed on the market. It is intended as a production instrument for making simultaneous and instantaneous commercial tests for all electrical defects and their locations in armatures and bare commutator in distinction to the present step by step method which frequently involves hundreds of distinct tests on the same armature. It is claimed that the armeter will indicate whether an armature is o.k. or if not will reveal such defects as: open circuits and where; bad joints (on coarse windings) and where; short circuits between sections and which; short circuited wind-

ings and where;mixed connections and how mixed; irregular number of turns and whether high or low; grounds; tests made at substantial potential, not micro voltages usually used; also instantaneous tests of all sections of a bare commutator for both short circuits and grounds.

Its tests are claimed to be superior tests for it is said to indicate defects that only show up in bad behaviour after running a while. To test an armature its commutator is slipped into the circle of contact fingers in the centre whereupon the circle of small lamps one for each section which are used for indicators will on normal armatures burn as with half voltage, on short circuits light up more or less bright, on open circuits extinguish. Bad joints (on coarse windings) and excess turns are indicated by dimness, other defects by other irregularities. A ground detector operates simultaneously. Lamps are used for indicators as their indications command attention better than eye straining needles. A pilot lamp indicates their correct reading. The entire device is said to be strong and durable and to have no delicate parts aand no moving parts except contact fingers. It is a production instrument not adjustable, but will also indicate shorts in higher voltage winding and open circuits on lower voltage windings at equal speed. It is manufactured by P. E. Chapman, St. Louis, Mo.

MOTOR-DRIVEN FLEXIBLE SHAFT

A motor driven flexible shaft outfit, the motor of which is enclosed in an aluminum casing having a base and handle vertical with it, has recently been placed on the market. A current of air is circulated between the wheel and the armature winding by means of a ventilating fan. The bearings are also cooled by a current of air passing between the scope of the sub-bearing and through a

Motor-driven flexible shaft.

series of holes around the bearings. The flexible portion of the shaft is ¼ in. in diameter, 3 ft. long and wound with wire. The outside covering is of whip cord; 6 ft. of drop cord with an attachment plug are provided with each motor. No external binding post is necessary as the cord is fastened inside the end plate. It is adaptable to all work ordinarily handled by flexible shafts equipment. These tools are being placed on the market by the Hergi Mfg. Co., Bridgeport, Conn.

SELF-OPENING STUD SETTER

A self-opening stud setter known as the Jarvis has recently been placed on the market. The tool is simple in design with all parts hardened, and providing a quick grip and release. These setters are made in three sizes with capacity of the small size up to ½ in. studs, the medium size taking studs up to ⅞ in., and the larger size handling studs up to 1¼ in. diam. Standard shanks are provided with these tools but shanks of special dimensions can be furnished if desired, also special sizes of jaws. These stud setters are being manufactured by the Geometric Tool Co., New Haven, Conn.

INTERESTING WATER WHEEL INSTALLATION

The Pelton Water Wheel Company has issued a 16-page illustrated booklet entitled "The Kern River Number Three Plant of the Southern California Edison Company," written by Ely C. Hutchinson, general manager of the Pelton Company. The hydraulic prime-mover equipment of this plant is particularly notable, since it comprises two 25,000 horsepower Pelton vertical turbines operating under a head of 810-feet, the highest head reaction turbines in the world. In addition, certain special operating requirements called for various novel features in the design of both turbines and accessory apparatus. Copies of the booklet may be obtained from either the San Francisco or the New York office of the company.

BELIEVES CANADA CAN SELL JAPAN GRINDING WHEELS

Writing from Yokohama, Japan, Mr. Malabar, in the office of the Canadian Trade Commissioner said that though the depression existing at the present time in Japan produced many orders being actually put through, investigations have been and are being made into the future possibilities and prospects for business in all the lines which Canada is in a position to export to Japan as favorably as any of her competitors.

"As a result of these investigations," says Mr. Malabar, "a very promising field for Canadian manufacturers opens up in the matter of exporting grinding wheels to Japan. Tentative inquiries made on all sides on this subject have elicited great interest, and several important firms in this country have expressed their desire to be put in touch with a Canadian manufacturer of grinding wheels in a position to export same to Japan, with a view to acquiring the sole agency for such.

"While it is impossible to state just what actual business would be forthcoming as a result of correspondence interchanged between the Canadian manufacturer and the Japanese importer of grinding wheels, still there is a demand, and directly trade conditions brighten it is safe to say that this demand will increase more and more."

Some English and American manufacturers of grinding wheels have obtained a foothold on this market for their products, and it is stated that they are doing well. A Japanese authority on this subject states that there is a considerable demand in this country for grinding wheels of the following specifications:—

Diameter 12 inches, bore 5 inches, thickness 1 inch, grade No. 46, hardness "T."

Diameter 12 inches, bore 1¼ inch, thickness 1¼ inch, grade No. 46, hardness "T" or "M."

Three stores and apartments costing $60,000 will be erected for J. C. Brady, 413 Palmerston Blvd., Toronto.

Management of Direct Current Machinery

By M. BARRY WATSON
Director of Engineering, Toronto Technical Schools.

MOST of the remarks on general care in the foregoing sections of this article apply to alternating current machinery as much as to direct current machines. The chief difference between these machines is that a commutator is made use of in the D. C. generator to rectify the alternating current generated in the armature coils, and in the case of a motor to change the direct current delivered to the machine to alternating current in the armature coils; whereas in the A. C. machines this is not necessary and the leads may be taken directly off from the coils of a stationary armature, or else the alternating current is brought out from a revolving armature by means of slip or collector rings and brushes.

The greatest part of the operating troubles with D. C. machinery is found to be in connection with the commutator, in the form of sparking or burning between the bars of the commutator, or between the commutator and the brushes. Some times burning takes place between slip rings and brushes, and some of the remarks made hereunder apply to collector rings as well as to commutators. The more usual causes of sparking or burning at the commutator will here be listed with such remedies as the operating engineer can apply.

Position of Brushes

The first requisite in regard to brush position is that all brushes or sets of brushes be spaced equal distances apart around the commutator. Before this can be checked up it must be ascertained that all brushes of one holder are in line with the commutator bars. Misalignment may have been caused by a bent brush holders stud, of by the individual holders on one stud being turned at different angles allowing different lengths of the brushes to protrude. If the stud is not straight, it may be taken out and straightened, or if bent near the brush holder ring, it may be shimmed straight by putting bevel washers under the shoulder and the nut on the stud.

The simplest way to see that all brushes are set equal distances apart is to cut a strip of paper the exact length of the circumstances of the commutator, divide it into as many equal parts as there are sets of brushes, raise the brushes and wrap the strip around the commutator. The tips of all brushes should be on the lines marked if they are properly spaced. Slight adjustments can be made by rotating the brush holder stud slightly. Some of the smaller multipolar machines of the "wave wound" type have only two sets of brushes, in such instances, these brusher should be one pole space apart, that is ¼, 1/6 or ⅛ of the total circumference depending on the number of main poles on the machine.

In operating shunt wound generators, it is necessary as the load increases to move the brushes forward (in the direction of rotation) in order to reduce the sparking to a minimum, by compensating for the distortion of the field flux caused by the current in the armature, which increases with the load. The position of least sparking must be found by trial as the load changes.

The brushes of shunt wound motors, on the other hand, must be moved backward with increases of load, and vice versa, in order to prevent excessive sparking. This applies only to medium and large machines, as the relatively small currents carried by little motors do practically no harm when the brushes are permanently set in a good position for average load conditions.

In modern commutating-pole or "interpole" machines the distortion of the magnetic field above referred to is automatically counteracted by the commutating poles, whose coils carry the armature current; thus no change of brush position is required for changes of load. However the correct position of the brushes on such machines should be determined with great accuracy to get the best results. This positioning is generally done by the manufacturer at the factory and marks are put on the frame and the brush holder ring which should coincide when the brushes are in correct position, or in some cases the brushes are mounted in an immovable position so that no mistake can be made in re-assembling or adjusting the machine.

In case the adjustment of the brush position on a commutating-pole machine is disturbed, it can be found by either of two methods. The simplest, but less accurate, is the "mechanical method." On machines where the armature coil width is exactly one pole pitch, the correct brush position is usually in line with the centres of the main poles. This position can be set approximately by sight, but more accurately by tracing the lead from the coil passing directly beneath the centre of the commutating pole to its commutator bar. The brush should be touching this bar. Since this method is not exact, some slight adjustment forward or back may be found necessary after the machine is operating under load to prevent sparking.

The electrical of "kick method" of finding correct brush position is more accurate, but requires the use of a low reading volt meter, say 7½ volts, and an independent voltage supply.

To use the electrical method, first set

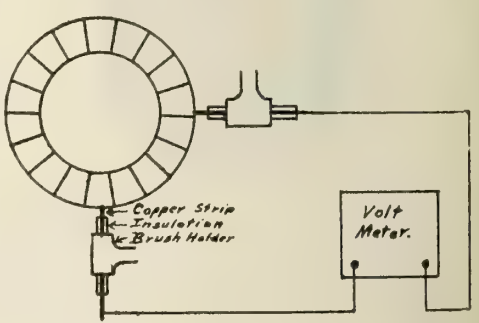
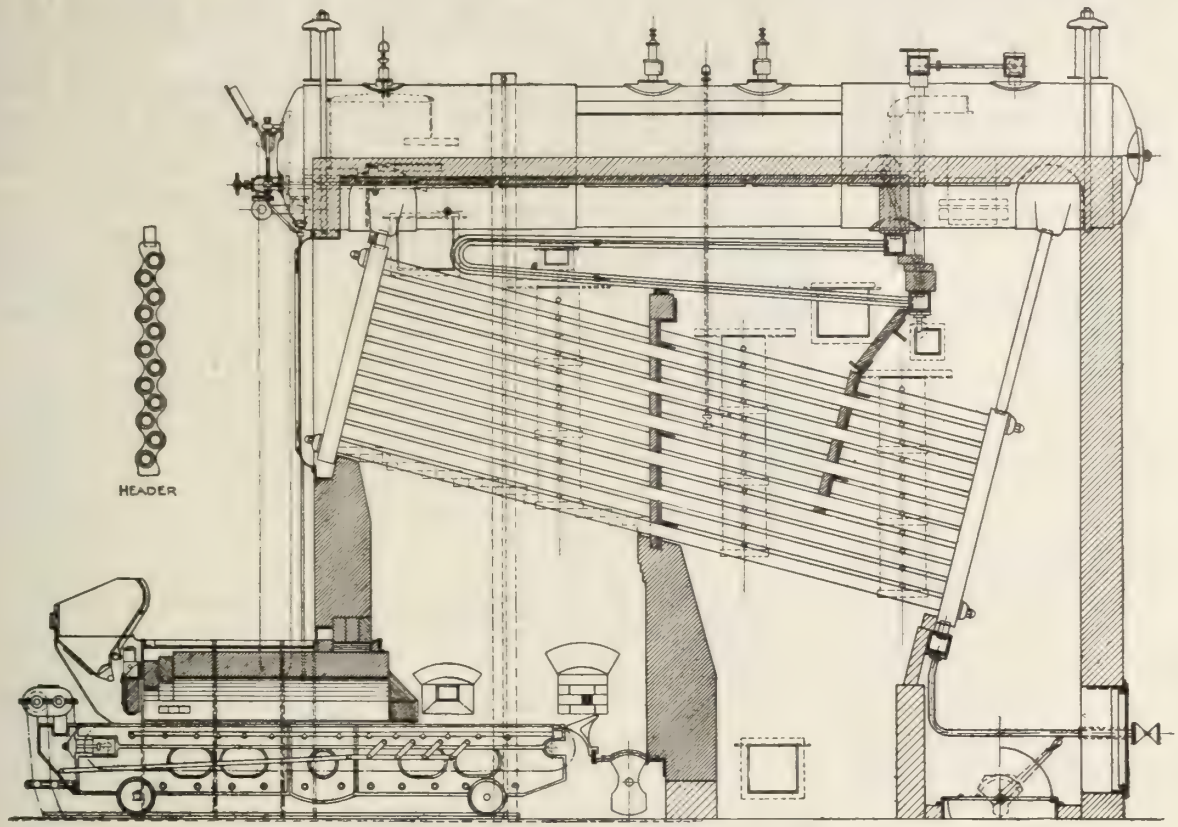


FIG. II

the brushes by the mechanical method, then remove all brushes from the holders, or insulate them from the commutator by sheets of paper. Make two pilot brushes of strips of dry wood or fibre

(Continued on page 38)

BOILER EFFICIENCY



Cut lent by courtesy of Engineering Institute of Canada.

Standard Longitudinal Drum Sectional Header Boiler

The laws of each province provide that every boiler operated within its boundaries must be built to certain recognized standards. All details such as seams, riveting, fittings, etc., must meet the approval of their inspectors before they will pass any boiler as safe to operate.

The Civil Law also states the lowest grade of engineer you can employ and how often he is required to prepare each boiler for inspection.

The lawmakers are concerned with the safety of the public, they do not make it compulsory for you to buy economical plant. You are expected, on your own judgment as a business man, to buy boilers which will give you the highest degree of safety and the greatest return for your money in pounds of water evaporated.

Now just as there are Civil Laws to make sure no unnecessary risks are taken by the public, so there are certain acknowledged engineering laws for the design and construction of economical boilers and furnaces. The success of all such equipment depends upon the success with which these laws, which safeguard your money, are applied—practically.

Boilers made by B. & W. are readily accepted by the authorities, even in the provinces with the stiffest requirements, because they are designed with a higher factor of safety than asked for, and no steam apparatus is made of better material or with more care. Every part is readily accessible inside and out, and with a responsible man in charge to see they are kept clean, there is little possibility of serious trouble.

As regards the efficiency of B. & W. steam plant, we can only ask you here to consider two factors—(1) THE EFFICIENT FURNACE because the fuel is fed evenly and intermixed with a proper amount of air while burning. Perfect combustion is produced and the fuel all gasified in the large combustion chamber before the heating surfaces are reached. (2) THE EFFICIENT HEATING SURFACE because of the proper circulation of the water and hot gases with reference to each other, and because they thoroughly interpenetrate each other, due to the arrangement of the baffles and the manner in which the tubes are staggered.

Babcock & Wilcox, Limited

Head Office for Canada: St. Henry, Montreal

Branch Office: Bank of Hamilton Bldg., TORONTO

MANAGEMENT OF DIRECT CURRENT

(Continued from page 36)

that will just fit the brush holders with pieces of copper strip or wire through their centres to make contact with the commutator, connecting these to a voltmeter as shown in Fig. II. Place these pilot brushes in two adjacent brush holders and supply the shunt field coils with about half their normal voltage. If the current is now suddenly broken there will be no movement of the voltmeter if the pilot brushes are exactly right. If no movement is shown the first time this is tried, put the brushes a little out of position so that a movement will be got to make sure the connections through the pilot brushes are alright, then place back to the correct position.

In multipolar machines, this position should be found for each adjacent pair of brush holders, and the final position taken as the average of the positions found. Some manufacturers supply templates with instructions for their use with their larger machines for the proper positioning of brushes.

Other Causes of Sparking

One troublesome cause of sparking is the overlapping of too many commutator bars by each brush, or by one row of brushes. This may be caused by a bent brush holder stud, which may be remedied as explained above; or the cause may be that the brushes in use are too thick or bearing on the commutator at too flat an angle so that the area in contact with the commutator is much wider than the thickness of the brush. The real cause of such sparking of course is that several coils of the armature are short-circuited through the tips of the brushes.

Too low a brush pressure will often cause sparking and burning at the commutator, because the brush does not remain in close contact with the commutator at all times, making either very high contact resistance, or an arc between the commutator and the brush. The usual pressures which will give satisfaction for carbon brushes on a commutator in good condition are as follows: For elevators, cranes, rolling mills, and other stationary motors which are very easily loaded and have frequent stops, 2½ to 5. For railway motors, 4 to 7 pounds per square inch of brush section. For example, assume a generator with brushes ⅝ inch thick and 1¼ inches wide, the area of brush contact is about 1-9/16 square inches, pressure per square inch should be about 2 lbs., or a total of about 3 lbs. per brush. Brush pressure can be measured most conveniently by hooking a spring balance to the holder spring at the point where it makes contact with the brush, and noting the pull when the spring is just raised from the top of the brush.

Too small or too few brushes, heavy overloads or brushes not fitting the curvature of the commutator will always cause a certain amount of burning cause the large currents are forced to go through such a small area. To fit the brushes to the commutator, raise the brushes and pass under them a sheet of fine sand paper, paper side to the commutator and rub it back and forth a few times until the brush tips come to correct shape, taking care that the ends of the paper are not raised above the commutator or the corners and edges of the brushes will bet rounded off too much, defeating the object of the sandpapering.

Brushes may at times get stuck, or may be tight in the holders and in that way fail to make sufficient contact with the commutator causing excessive sparking. Clean out the brush holders with gasoline, if this is not sufficient, see that the inside of the holders are free from burrs or roughness using a fine file. If the brushes are too wide or too thick, they should be rubbed down on a sheet of sand paper, care being taken that they are not made too loose.

Sometimes vibration of the whole machine is responsible for considerable sparking at the commutator. This may be caused by an unsolid foundation, the pound of reciprocating enginees, poor belt lacing or joints, or unbalanced armature. In some cases it may be caused by insufficient flywheel weight when generators are operated in parallel driven by reciprocating engines. The remedies for the above causes are obvious.

Unequal air gaps between pole faces

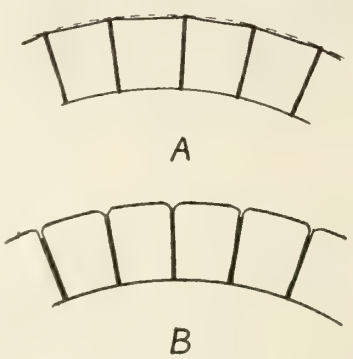


FIG. III

and the armature may cause bad sparking at times. This may be remedied by shimming the poles out, or by rebabbitting or renewing the bearings properly centred.

Poor electrical connection between brushes and holders causes excessive heating and sparking. See that the holders and brushes are thoroughly clean, that the brushes fit the holders accurately and that all connections are tight. Use copper plated brushes and shunts or "Pigtails" properly connected. In using copper-plated brushes on slotted commutators, it is generally necessary to bevel off the edges of the brushes to prevent the copper coating from becoming ragged at the edges of the brushes and causing sparking.

Chattering of the brushes will cause excessive sparking accompanied by noise. This may be the result of the brushes being too loose in the holders, or not sufficient brush pressure. It may be caused by dirty or rough commutator, high mica, high or low bars, flat spots or eccentric commutator.

Broken armature coils usually cause sparking and burning of the corresponding bars. Needless to say this should be repaired as soon as possible to prevent the formation of flat spots on the commutator. The coils can be tested by unsoldering the coil leads from the commutator bars and testing for broken circuit with a magneto, bell and battery or a lamp and normal voltage.

Cleaning and Polishing Commutators

Commutators may be cleaned with sandpaper or gasoline if not out of true. A very fine grade of sandpaper should be used and applied very lightly, preferably by being attached to a block of wood cut to fit the commutator. On unslotted commutators, that is where the mica or insulation between the bars is flush with the surface of the commutator, sandpaper has a tendency to flatten the center of each bar leaving the mica and edges of the bars slightly higher as shown in Figure IIIa. This can be prevented to a certain extent by using a very little oil on the sandpaper, which makes the mica cut easier and reduces the cutting effect on the copper. Very much sandpapering should not be done, or particles of the sand with some of the copper dust will become imbedded between the bars causing partial short circuits and burning. If burning from this cause has been taking place, clean out the space around the burnt spot down to the solid mica and fill the space with Sodium silicate (water glass) or some of the patent commutator compounds on the market.

On a slotted commutator oil should not be used with the sandpaper, as it will cause the copper dust to collect in the spaces between the bars. If used dry the centrifugal force of the revolving commutator tends to throw out any copper dust and sand collected in the slots. On a slotted commutator sandpaper has a tendency to cut more material off the edges than off the centre of the bars giving a rounded surface to the top of the bar and a small area of contact for the brushes causing excessive heating. This is illustrated in Fig. IIIb.

Emery cloth or paper must never be used on a commutator, because emery is an electrical conductor, and if particles become imbedded between the bars, a short circuit and burning is the result.

Hand-Stoning

A very fine grained sand stone may be held by hand flat against the commutator to polish it. This is much superior to sandpapering especially if formed to the curvature of the commutator, because being unflexible, it does not flatten the centres or edgs of the bars. The particles are also more firmly

(Continued on Page 40)

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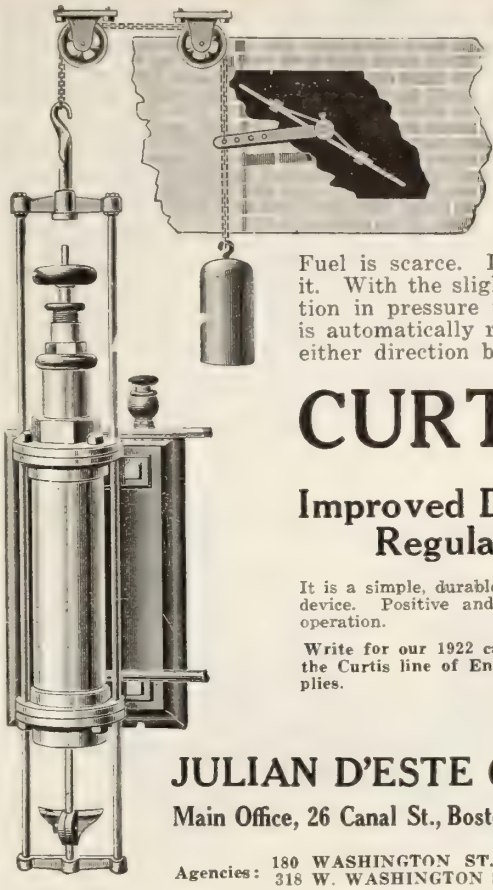

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READ and STUDY the ADVERTISEMENTS

HOW TO FIGURE THE COST OF TIGHT BELTS

By W. F. Schaphorst

In power transmission through belting we have some rather peculiar conditions to contend with. Run the belts tight and the bearings will consume too much power. Slacken the belt and it may slip and we then have the power loss due to belt slip which amounts to one per cent. of the power for each per cent. of slip. With a given belt, then, it may be possible to permit slip to some extent and still save power by running the belt rather loose. But, again, by permitting slip, we are permitting our belts to wear away faster, and the cost of belt renewal may be considerable. It is evident, then, that the ideal condition is to run belts slack if possible, at the same time preventing slip. This condition is possible and is being successfully accomplished by means of proper belt care.

To emphasize the value of running belts properly I have developed a formula which gives the money saved per year by converting a tight, slipping belt drive into a loose, non-slipping drive. This formula includes the cost due to power absorbed by the journals and the power lost through slip. It does not include the cost of belt wear, though, that is a factor that cannot easily be computed mathematically, if at all. Here is the formula:

Cost per year in dollars=

$$\left(\frac{W V^2 (T-t)}{17{,}688\, T\, t} \times \frac{S\, P}{100} C\, N\, D\right)$$

where

W = Weight in pounds of the engine flywheel;

V = Velocity in feet per second of the periphery of the flywheel while running at normal speed;

S = Per cent. of belt slip saved due to belt care and improved methods. For example, if the belt slipped 4 per cent. while running tight and 2 per cent. while running slack, the saving would be (4 minus 2 equals 2) 2 per cent., which should be used in the formula.

P = Horse power of the engine.

C = Cost of power in dollars per horse power hour.

N = Number of working hours per day.

D = Number of working days per year.

T = Time in seconds required for the engine flywheel to come to a dead stop after shutting off steam or gas. The steam or gas should be shut off as quickly as possible. Engine should be driving the belt and pulleys only and driven machinery should be thrown off of the line if possible, in order not to interfere with the test. T, then, is the time required to come to a stop with belt running slack.

t = Time in seconds required for the flywheel to come to rest with belt running tight.

It is evident that T will be greater than t, because with the lessened power consumption of the bearings it will take longer for the stored energy in the flywheel to be consumed. This formula requires at least four tests: First, the belt slip while running tight; second, the stopping time while running tight; third, the belt slip while running slack, and fourth, the stopping time while running slack. Should it be found that there is more slip when running slack than when running tight, the value $\frac{S\, P}{100}$ would be negative, and it may be found that the advantages of slack running are lost. Whatever happens, this formula will tell the truth.

Let us choose a concrete example, where:

W = 3,000 pounds.

V = a mile a minute, = 88 ft. per sec.;

S = 3 per cent;

P = 200 h. p.;

C = $.015;

N = 12;

D = 300;

T = 180 seconds;

t = 150 seconds;

$$\left(\frac{3{,}000 \times 88 \times 88\ (180-150)}{17{,}688 \times 180 \times 150} \times \frac{3 \times 200}{100}\right)$$

$.015 x 12 x 300 = $472.

A saving of four hundred and seventy-two dollars per year should make a test like this well worth the while of any power plant engineer.

MANAGEMENT OF DIRECT CURRENT

(Continued from Page 38)

imbedded in the stone than on the paper and are therefore less likely to wear off and stick to the commutator. Oil is unnecessary in hand-stoning. High mica can be remedied by means of a hand stone, also high bars of flat spots if not of too great extent. It will not however correct eccentricity of the commutator. The machine should be run at normal speed for hand-stoning.

In either sandpapering or hand-stoning great care must be taken not to make diagonal scratches on the commutator. This is especially important in the case of slotted commutators, as non-abrasive brushes are used, and will be worn away rapidly by the slightest roughness instead of polishing out the scratches.

After polishing the commutator the machine should be given a thorough cleaning to see that the copper dust is not sticking to the windings, etc.

(To be continued)

NATIONAL ASSOCIATION OF PRACTICAL REFRIGERATION ENGINEERS THIRTEENTH ANNUAL CONVENTION

The dates for the Thirteenth Annual Convention and Exhibition of the National Association of Practical Refrigerating Engineers have just been announced. This important Convention will be held on November 1, 2, 3 and 4, 1922, at the Planters Hotel in St. Louis, where the entire second floor of that well known hotel, which is one of the largest in St. Louis, has been engaged for exhibition and meeting purposes.

The National Association of Practical Refrigerating Engineers is an Association composed of chief and operating refrigerating engineers, for the purpose of further educating the members of the profession in the art and science of refrigeration engineering.

The National Educational and Examining Board of the Association, after much labor, several months ago commenced to furnish the members with a Lecture Course on the fundamental principles of refrigeration. The Lecture Course is in twenty-two parts and is conceded by many of the best minds in the profession to be the most complete of anything ever written on the subject. This, along with the other educational features offered by the Association, is available only to members.

The cost of joining the Association is so small that every refrigerating engineer should become a member. The initiation fee is only $5, and the dues at the rate of fifty cents a month. For further particulars we are pleased to refer you to Edward H. Fox, Secretary, 5707 West Lake Street, Chicago, Illinois.

Analysis of the gases arising from the fuel bed of a forced draft chain-grate stoker, in tests being conducted at Pittsburgh, Pa., by the Bureau of Mines, show that large quantities of combustible gases rise from the central portion of the grate, while near the back much excess air and little combustible gas are present.

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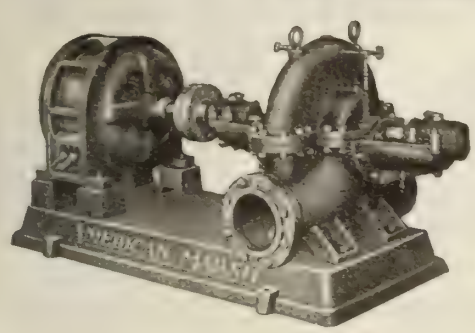

Designed for use in power plants where absolute reliability and high efficiency are essential. For over thirty-five years American-Marsh Pumps have been recognized as standard throughout the Dominion. There are over 160,000 in successful operation.

The sturdy rugged construction and heavy cast bronze fittings insure long life and a minimum repair expense.

American-Marsh Centrifugal Pumps are built with the same painstaking care that characterizes the construction of the direct acting line.

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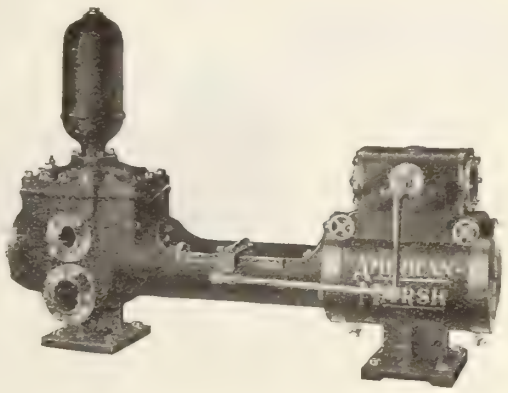

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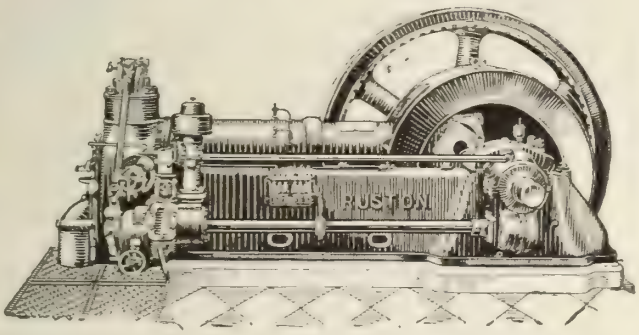

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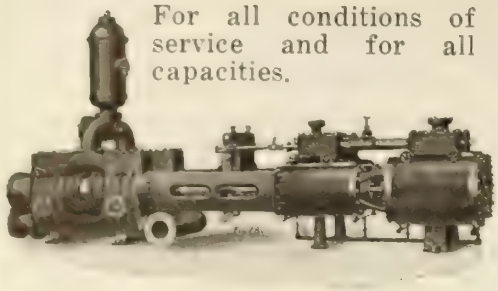

Fig. 7481.

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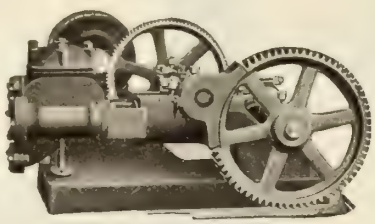

Fig. 7464.

All designed

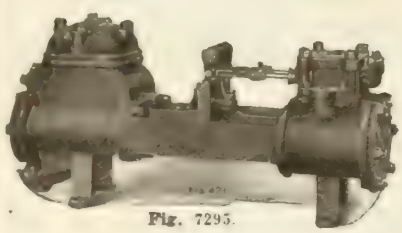

Fig. 7295.

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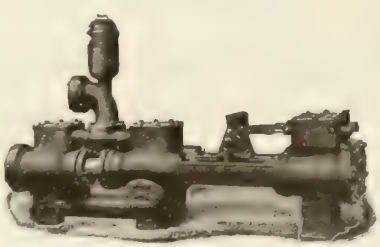

Fig. 7284.

Fig. 7242.

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To adopt technical paper advertising provides a desirable connection for any manufacturer.

The power plant owner, superintendent, or operator, always consults his technical paper—he reads it thoroughly—or as one subscriber recently wrote:

> *"It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages SO MUCH AS ON THE ADVERTISEMENT PAGES."*

The argument that the daily newspaper provides adequate "buying power" for the manufacturer of machinery, power plant equipment, etc., is unsound. The "Toronto Globe," in its issue of June 9th, 1922, said: "The newspaper on which hours were spent in less strenuous times, is now 'read' in ten or fifteen minutes at breakfast or after tea." Promote your advertising in the technical papers—papers that the users of your equipment depend upon.

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Limited

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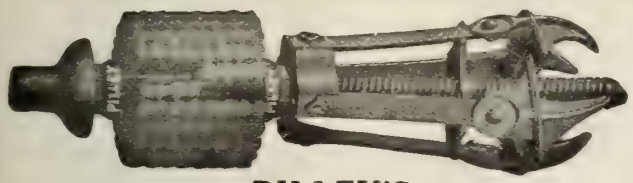

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For sale by leading Canadian jobbers.
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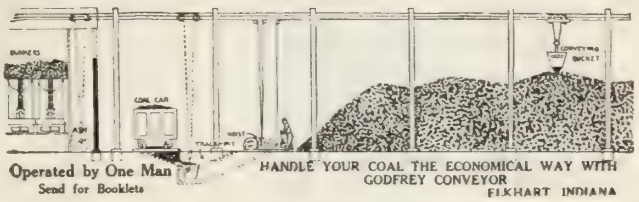

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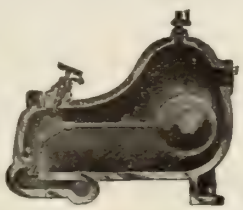

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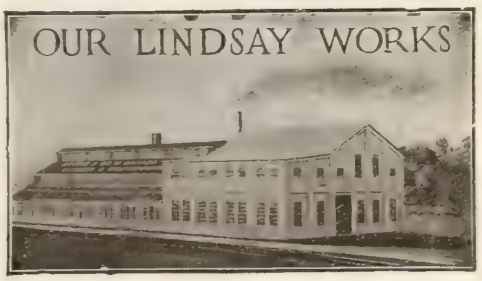

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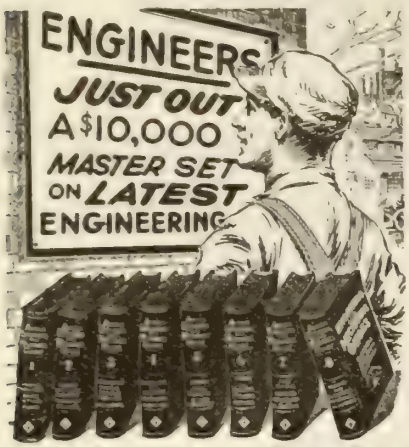

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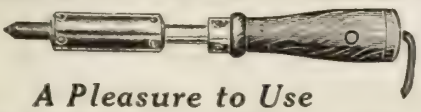

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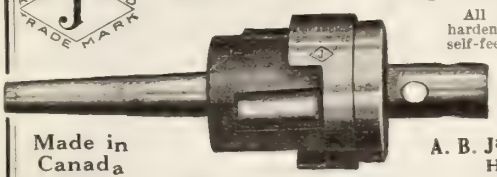

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The Mason Regulator & Engine Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

CORD CLOTHING
D. K. McLaren Ltd., Montreal, Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd. Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. A., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Beveridge Supply Co. Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W.R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCullough Co., Galt.
Leonard & Sons, Ltd, E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd, Toronto.
Gelinas & Pennock, Reg'd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co. Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

Coal Strike

This again brings up the question of Fuel Economy.

Users of **PLIBRICO** Jointless Fire Brick and of our other Fuel Savers can now contemplate a nice reserve effected through use of these lines. This will enable them to meet emergencies and tide over present difficult times. **PLIBRICO** specially suited for Oil Burning Furnaces.

PLIBRICO Bond High Temperature Cements.

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Which will give the better service—a furnace lining made up of many bricks bonded together, or one of a refractory material that is molded into shape when plastic, forming a one-piece, *jointless* lining?

The latter, most certainly, everywhere known as

PLIBRICO JOINTLESS FURNACE LINING

PLIBRICO is easily applied; it has *no joints* where disintregation may start; it is unaffected by heat up to 3100° F.; it outlasts laid-up fire brick from two to four times; it permits the production of more power at less fuel expense; it lessens labor expense. In a word, PLIBRICO meets the present-day need for a furnace lining that *endures*.

Don't you want to know more about PLIBRICO? Send for our book L-67, on "Modern Furnace Building," and ask to have our nearest representative call.

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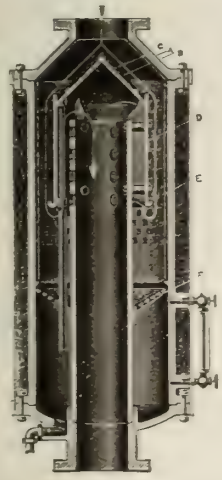
10,000 Sweet's Separators are serving discriminating steam users around the world.



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Read our story before buying.

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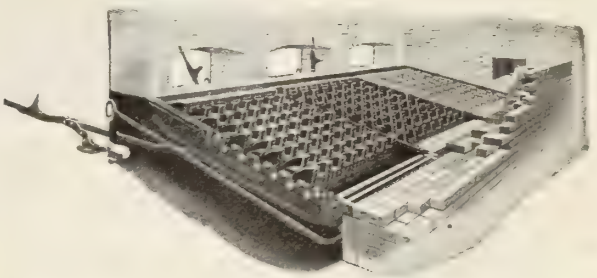
Self Cleaning *Hand Operated*



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EASY TO OPERATE
INCREASE CAPACITY
ELIMINATE SMOKE
HIGH RATINGS
INCREASE EFFICIENCY
COST REASONABLE
SAVE COAL
INCREASE EVAPORATION
GUARANTEE RESULTS
UNIFORM FIRE BED
FIRES ALWAYS CLEAN
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The Best Hand Stoker Built

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Canadian Johns-Manville Co. Ltd., Toronto
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
B. C. Miller Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnall-Waring Co., Philadelphia, Pa.

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Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West Toronto.
MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

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Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

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COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

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Laurie & Lamb, Montreal.

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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
MacGovern & Co., Inc., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

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Builders Supply Co., Montreal.

CONDUITS
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CONDENSATION RECEIVER
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CONNECTING RODS
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MacKinnon Steel Co., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.

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Godfrey Conveyor Co., Elkhart, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insultaion Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y.

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Can. Fairbanks-Morse Co. Ltd., Montreal

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach., Co. Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Babcock Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaffer & Budenburg Mfg. Co., Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRILL RODS
Lincoln Electric Co., of Can. Ltd., Toronto

DROP- FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg., Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, ue.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal.
B. F. Sturtevant Co., Boston, Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
MacKinnon Steel Co., Ltd., Sherbroke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Pelt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co., of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg., Co., Toronto.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Out.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F. Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N.Y.

EYE BOLTS

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The Montreal.
Sturtevant Co., B. F. Toronto, Can.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co., Montreal, Que.

FEED WATER PURIFIERS
Grover Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

FILTERS
Grover Corp., East Chicago, Ind.
S. F. Bowser Co., Ltd., Toronto., Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Grover Corp., East Chicago, Ind.
MacKinnon Steel Co., Ltd., Sherbrooke.
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittsburgh, Pa
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATION SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Grover Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal .
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYRDAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane Limited, Montreal.

FITTINGS, CAST IRON
Crane Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

Stop Wasting Oil

The De Laval Oil Purifier returns to service lubricating oil or transformer oil which would otherwise be thrown out. Better still, its continued use constantly maintains the efficiency of such oils.

The De Laval does its work instantaneously, thoroughly and economically by centrifugal force. It is the modern method of making turbines and Diesels give longer and better service, and of prolonging the life of the oil used to lubricate them. It is the far more economical method of maintaining the dielectric strength of transformer oil.

No matter which of these tasks you give a De Laval—you can use the same machine for both—you have absolute assurance that the work is being done better and more economically.

Write for Bulletin No. 105

The De Laval Co., Ltd
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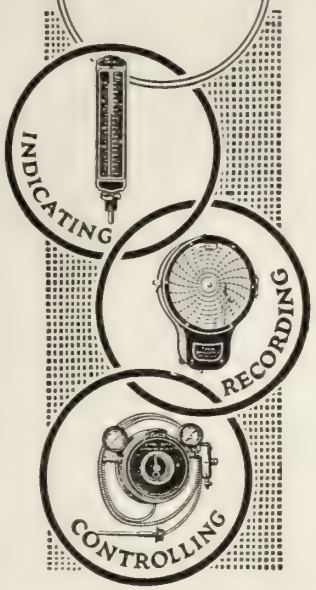
Tycos Temperature Instruments



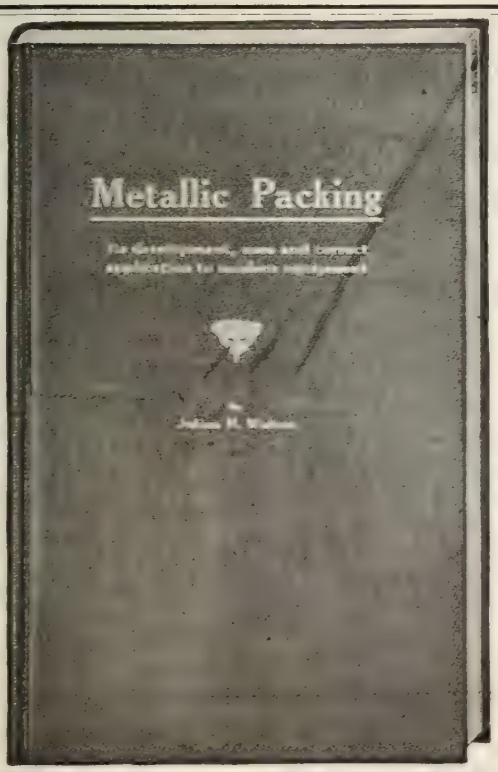
OPERATIVES

appreciate the assistance of *Tycos* temperature instruments—indicating, recording, controlling—in the attainment of a high rate of personal efficiency.

Catalogue upon request. Give firm connection if you please.

Taylor Instrument Companies
110-112 Church St., Toronto, Ont.
Theres a *Tycos* and *Taylor* temperature instrument for every purpose

825



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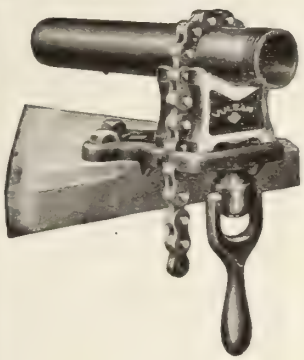

Williams' "Vulcan" Chain Pipe Vise

UNBREAKABLE, compact, rapid in action and positive in gripping pipe. Attachable **anywhere**—any handy bench, post or other support will serve.

Made entirely of wrought steel; the drop-forged jaws are saw-tempered for file sharpening and the hand-made chains are of the same superior quality as those of our well-known "Vulcan" Chain Pipe Wrenches.

Vises in 3 sizes for ⅛ to 8-inch pipe. Booklet on request.

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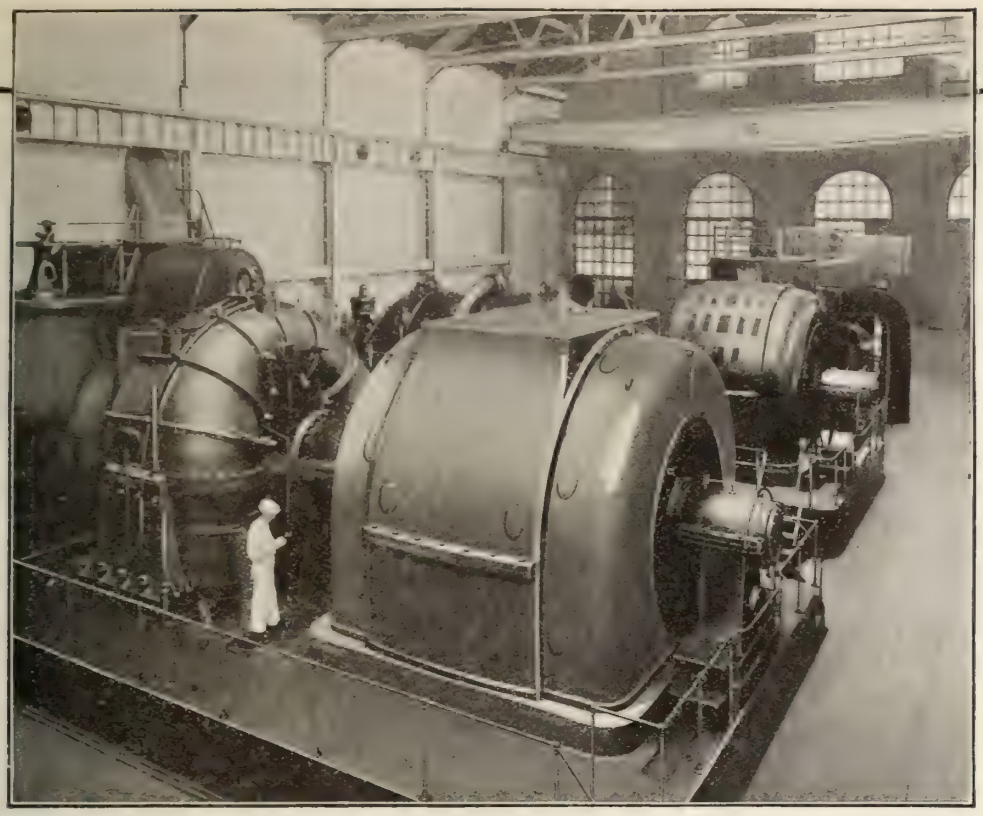

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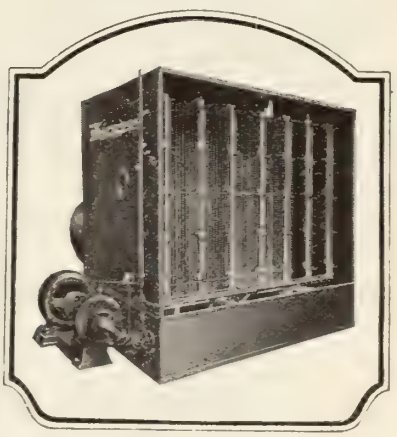
The air must be clean in order to prevent accumulation of dust in windings. Dirt reduces conductivity, prevents quick dissipation of heat, makes overheating certain.

"Sirocco" Air Washing Equipment furnishes cool, clean air in just the volume desired and enables you to lower the temperature of generators and motors to a point that insures maximum operating efficiency.

Complete information regarding "Sirocco" Air Washing Equipment for the small power plant or the mammoth central station will be sent you upon request.

Facts and figures regarding "Sirocco" Equipment for your particular requirements will be forwarded you upon receipt of data regarding the electrical equipment that you desire to cool with washed air.

"Sirocco" Air Washers are being used by many power plants for cooling generators and motors.



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(117)

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Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

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Pratt & Cady, Hartford, Conn.
Smart Turner Co., Hamilton, Ont.
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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
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Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton.

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Waterous Engine Works

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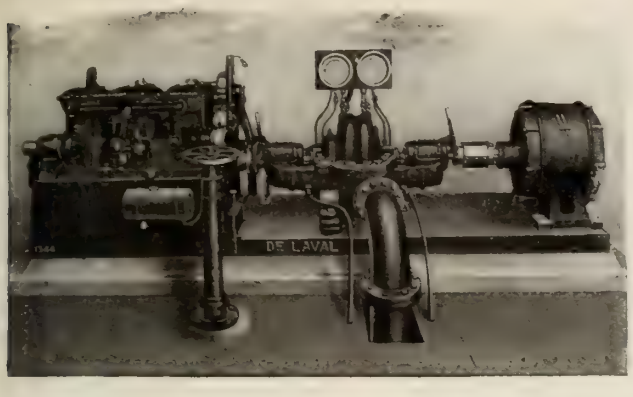

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Jas. Morrison Brass Mfg. Co., Toronto.
The Reliance Gauge Column Co., Cleveland, Ohio.

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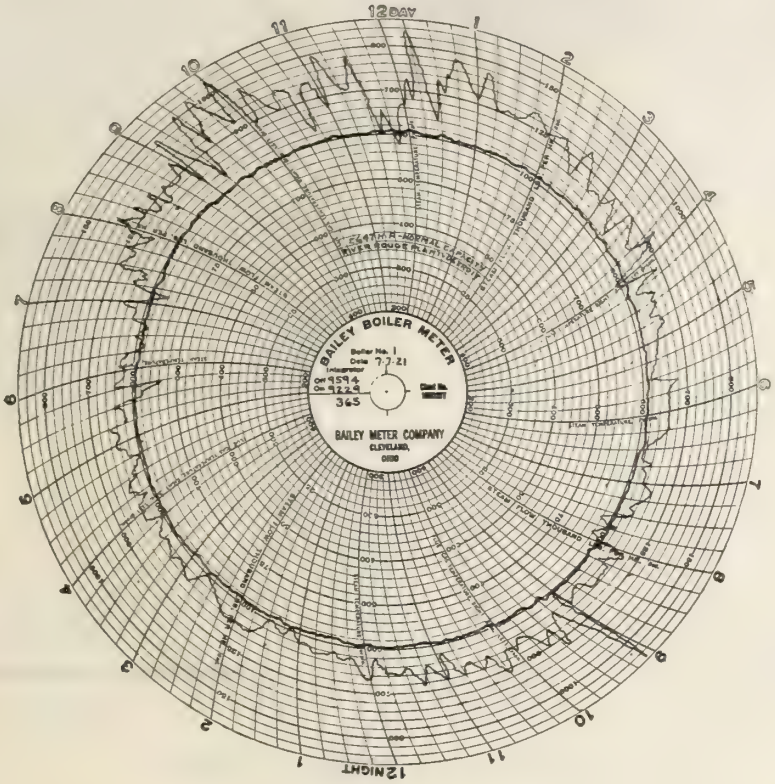
Constant Steam Temperatures Maintained with ELESCO Superheaters at the Ford Motor Company, River Rouge Plant



Maintenance of superheated steam temperatures nearly constant under a wide range of boiler loads, is shown on the above chart taken from one of the 2,647 H.P. boilers at the River Rouge plant of the Ford Motor Company.

The outside irregular line indicates the steam flow, which under normal operation at 100% boiler rating is 82,586 lbs. per hour. It will be seen that this varies from 163,000 lbs. maximum 197.5% rating to 84,000 lbs. minimum 101.6% rating.

The even inside line indicates steam temperatures. At normal pressure (225 lbs. gauge) the approximate temperature of 200 deg. superheat is 600 deg. F. It will be noted that the variation in steam temperature, from 615 deg. maximum to 588 deg. minimum is but 4.5%.

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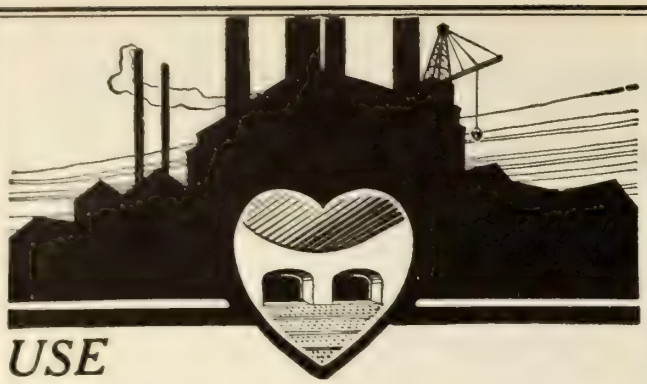

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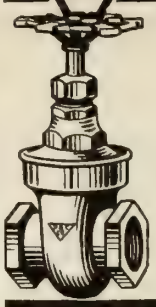
P&C CO



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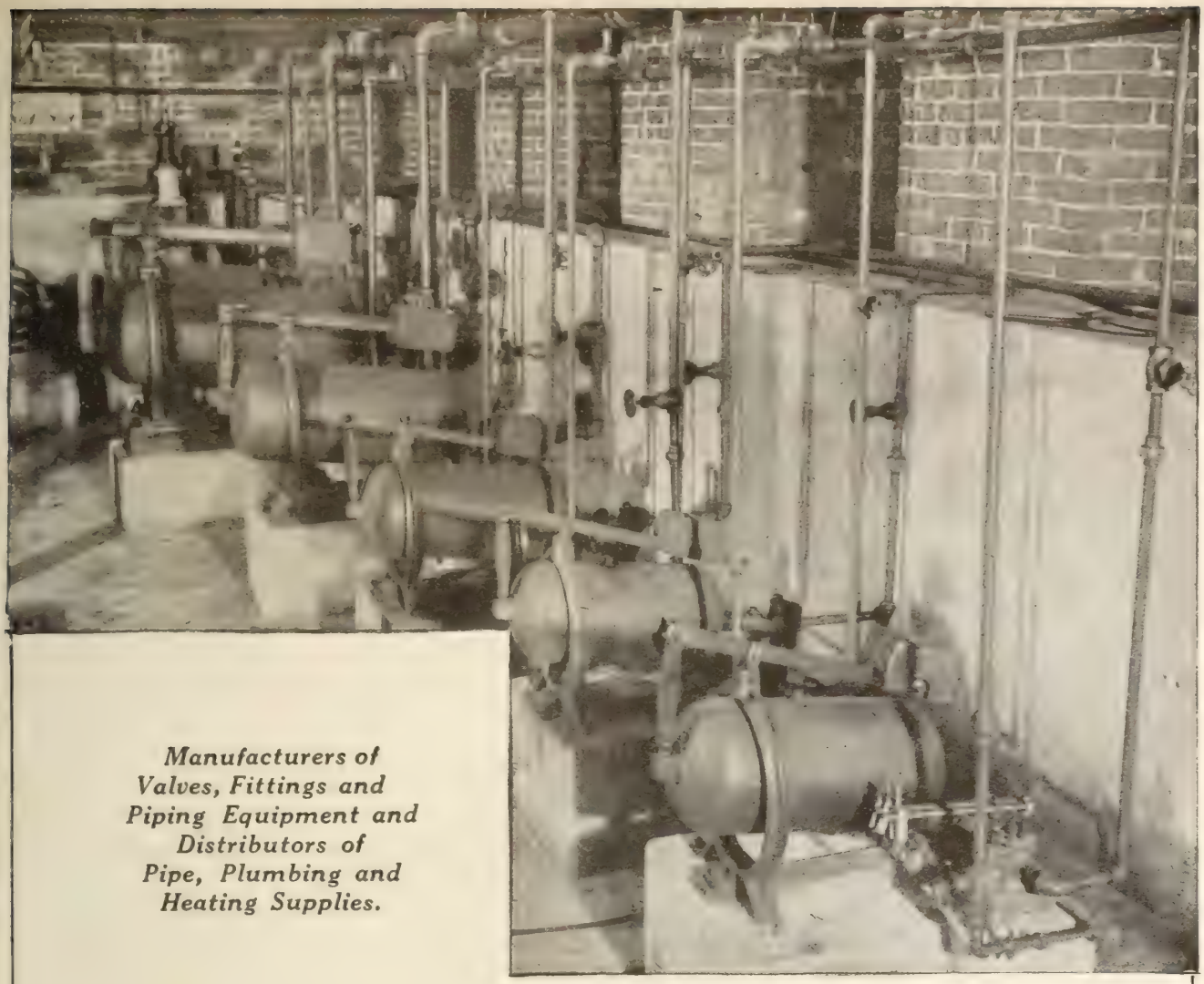

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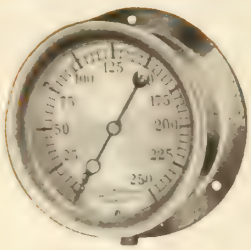

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Vol. XV.—No. 14 — Publication Office, Toronto—July 20, 1922 — Published Semi-Monthly Canada, $2; U.S. $2.50 a year

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Fig. 106
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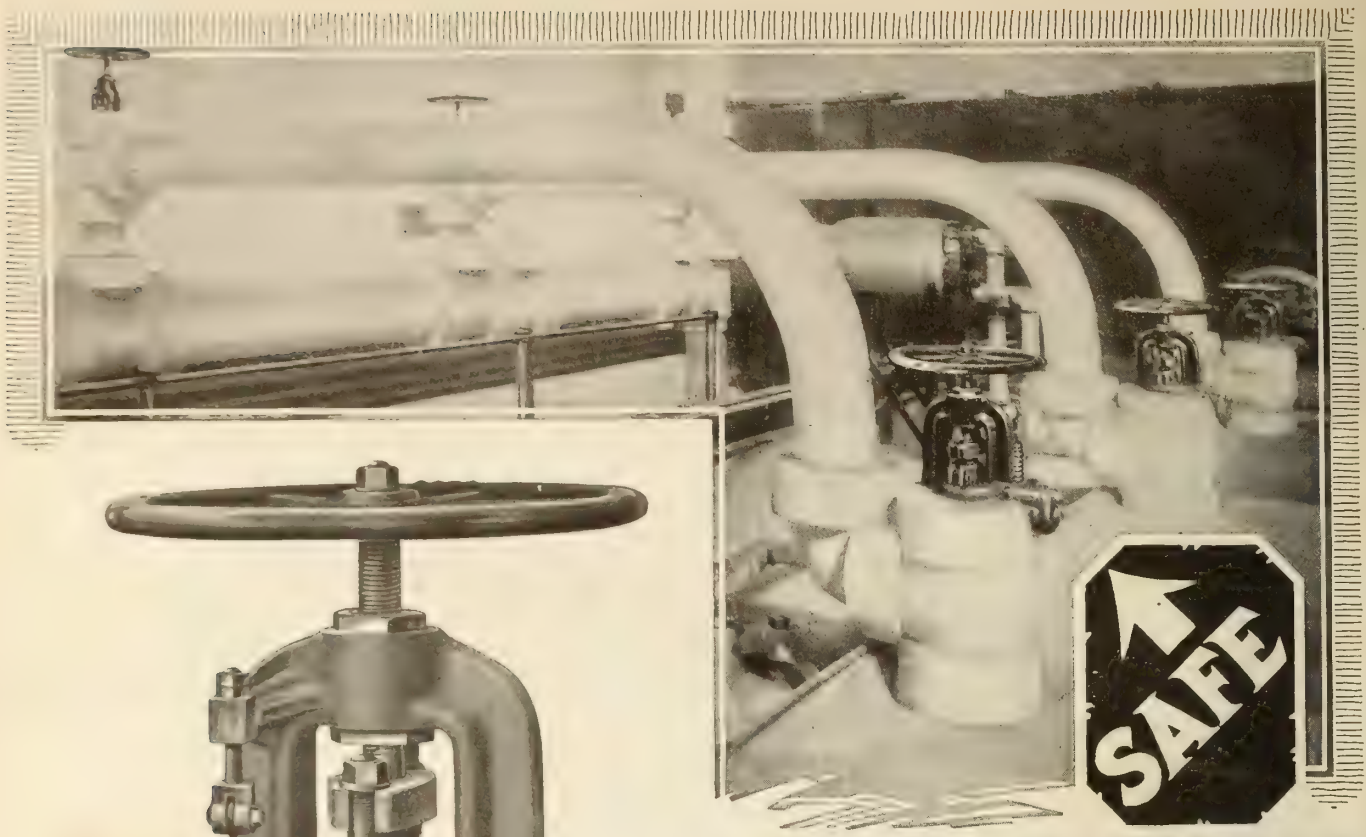

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are safety devices of established merit, providing positive protection to the operatives as well as the plant itself, against the dangers incident to an internal accident to one of the boilers of a battery.

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GENERAL OFFICES AND FACTORIES
SHERBROOKE, QUE.

SHERBROOKE, CANADA September 23, 1921.

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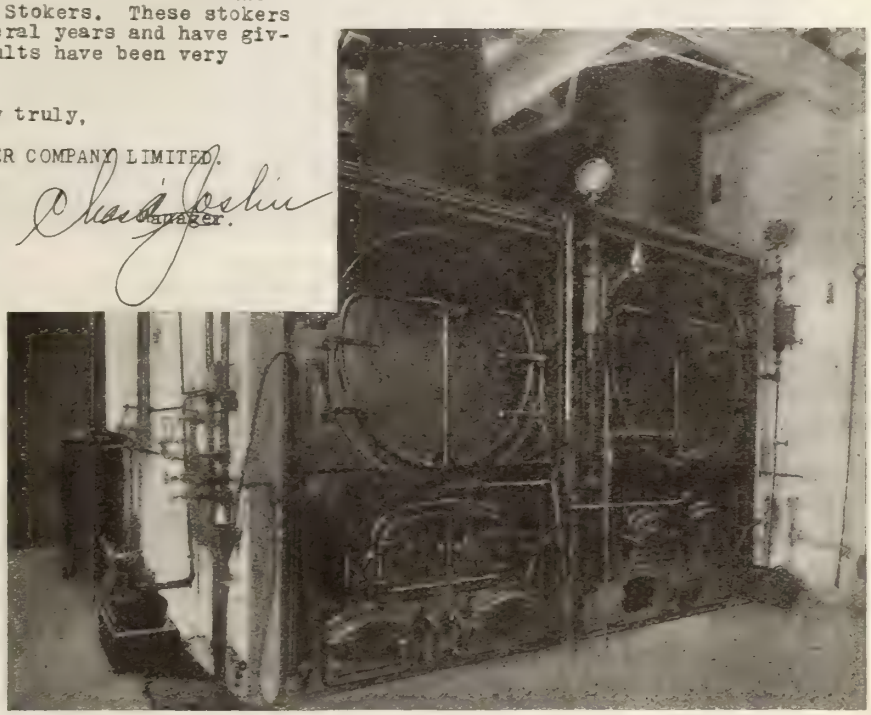
In reply to your letter of the 8th instant we have in our plant the Files Stokers. These stokers have been in operation for several years and have given excellent service. The results have been very satisfactory.

Yours very truly,

PANTHER RUBBER COMPANY LIMITED.

Chas. A. Jodoin
Engineer.

CAJ/RMK



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The Waterous Engine Works Company, Ltd.

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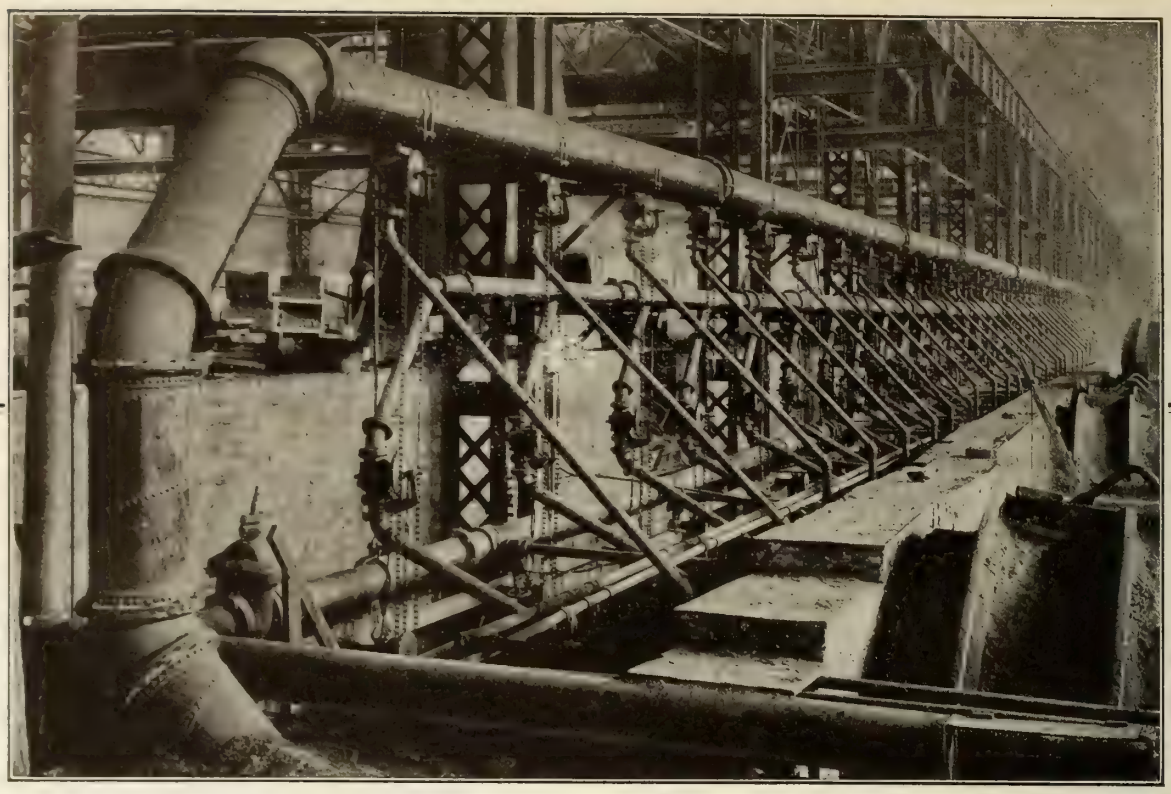

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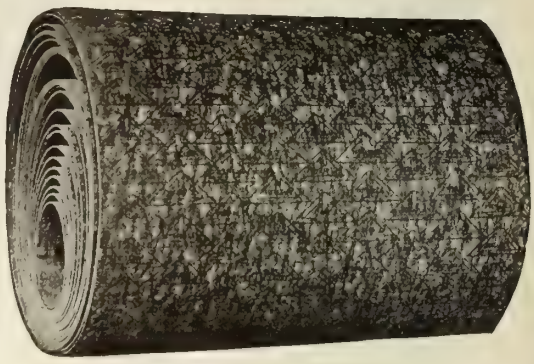

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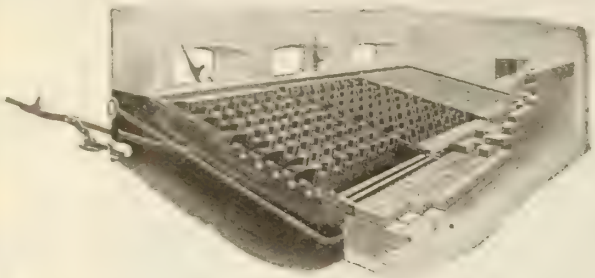

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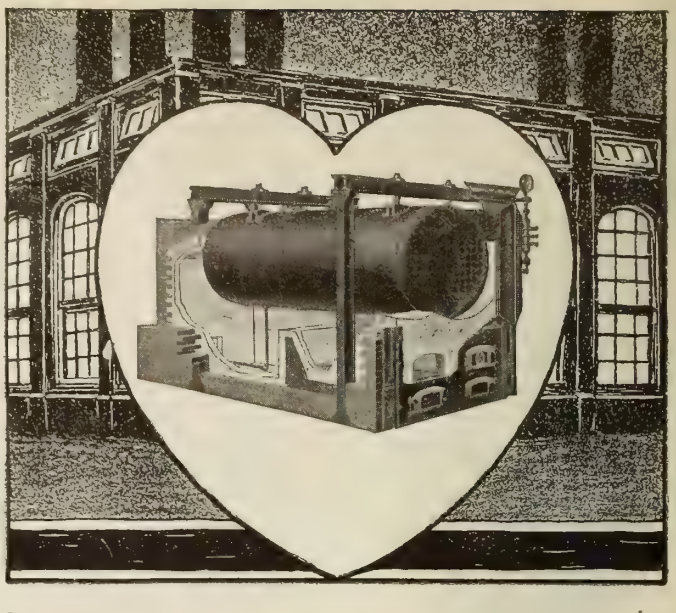

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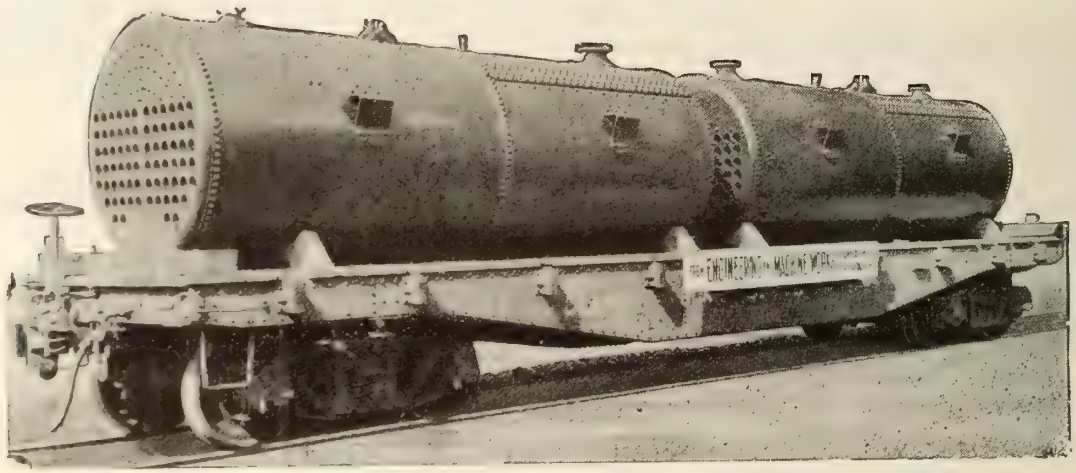

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Co-operation in Education

By Joseph Lister

A movement is on foot to bring about an amalgamation of a number of the Colleges in the Maritime Provinces. Mr. Lister points out some of the advantages which will accrue from the proposed pooling of resources.

Is "WELCOME" on Your Door Mat?

By Beatrice M. Hay Shaw

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By F. Gordon Sampson.

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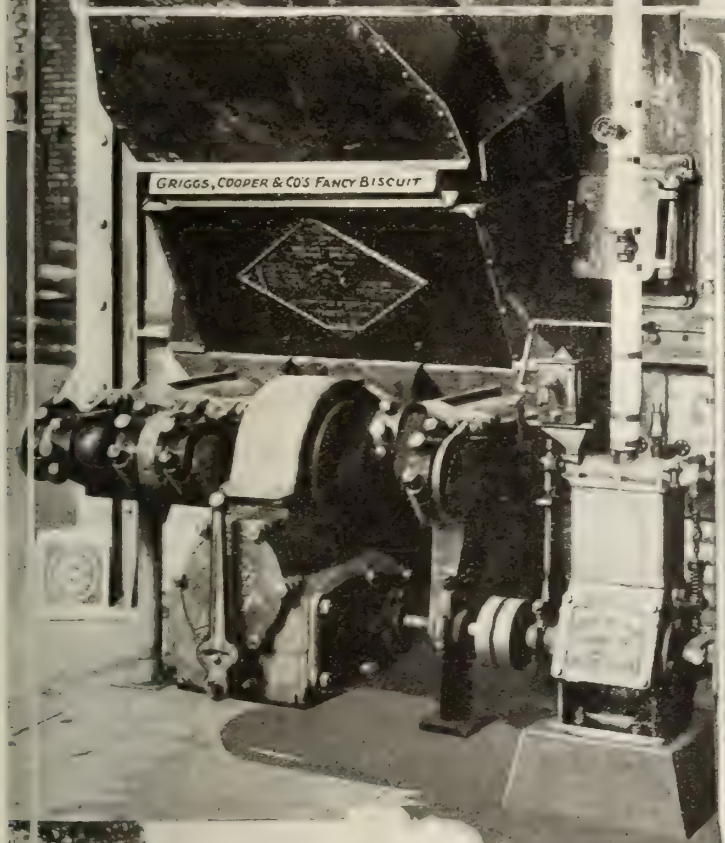
RILEY UNDERFEED STOKERS



Not only in central stations, and large industrial plants, is the RILEY STOKER meeting steam demands, but also in plants using smaller boiler units. Such a case is the installation at Griggs-Cooper & Co., Manufacturing Wholesale Grocers, St. Paul, Minn.

Here a 200 HP boiler is fired by a three (3) retort RILEY UNDERFEED STOKER, the fuel used being Illinois screenings.

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it gives you all the details.

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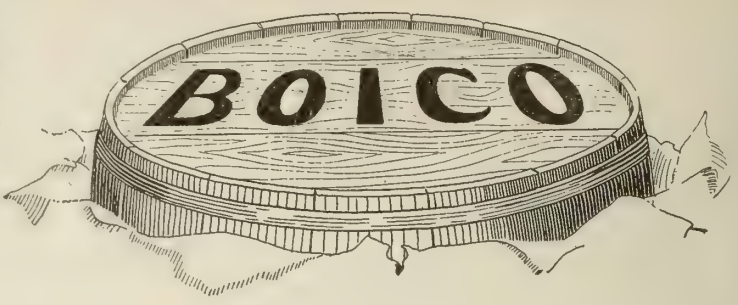
The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.



Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 1-15 Saunders Ave., **Toronto**

Sales Agents: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

MR. ENGINEER!

You want the latest information regarding power plant, refrigeration and heating equipment, and the place to get this is in the Advertising pages of **Power House.** Note the list:—

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- Air Compressors
- Condensing Equipment
- Pumps
- Motors
- Refrigeration Equipment
- Water Screens
- Piston Rings

Boilers and Accessories
- Boilers
- Boiler Tubes
- Tube Protectors
- Water Columns
- Gauges
- Gauge Glasses
- Boiler Feed Regulators
- Superheaters
- Flow Meters
- Tube Cleaners
- Soot Blowers
- Baffle Walls
- Arches

Coal and Ash Handling
- Conveyors
- Conveyor Belts
- Coal Crushers
- Coal Meters
- Ash Conveyors

Combustion
- Furnaces
- Refractories
- Chimneys
- Stokers
- Grates
- Pulverized Fuel Systems
- Oil Burners
- Agitators
- Fans
- Blowers
- Draft Regulators
- CO_2 Recorders

Feed Water Equipment
- Water Treatment
- Venturi Meters
- Feed Water Heaters
- Economizers

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- Separators
- Steam Traps
- Packing
- Ventilators
- Flooring and Steps
- Heat Regulators
- Cranes
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- Pipe Tools
- Expansion Joints
- Pipe Clamps
- Iron Cement
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- Turbines
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- Ice Making
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Power House advertisers are at your service. Many engineers have been enabled to qualify for better positions, have been instrumental in securing the installation of more efficient equipment, have been of exceptional service to the firm they are engaged by, **because** of their superior knowledge of equipment, which knowledge was largely attained by being conversant with the latest advertised equipment, found in **Power House.**

READ and STUDY the ADVERTISEMENTS

More or Less Boilers?

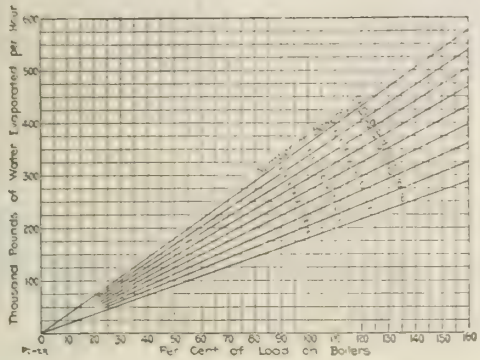

Chart showing number of Boilers to operate.

the horizontal scale is the load in percentage of boiler rating (it having been previously determined at what overload this type of boiler will generate steam with maximum efficiency); the diagonal lines represent the number of boilers in service. The diagram tells immediately whether more or less boilers should be in service for the rate of steaming shown by the Venturi Meter. This is only one of many ways to change the information given by the Venturi Meter into a real money saving which continues as long as the plant is operated.

The VENTURI Meter

"VENTURI" Registered Trade Mark

Answers This Question

At this most critical time in American industry, when careful far-sighted management is an absolute requirement for any successful business, why not squeeze every bit of energy from your costly fuel used in the boiler plant? The accompanying cut shows a chart devised by a prominent meat-packing concern, to make certain that enough and only enough boilers are used to take care of the load.

Do you wish further details?

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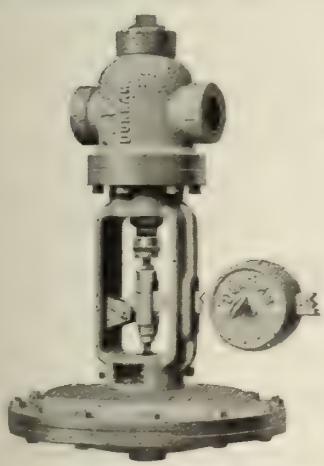


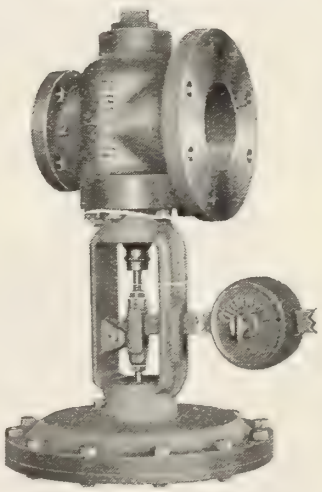
Dunham Reducing Pressure Valve Type 300

The DUNHAM HEATING SERVICE

REG. TRADE-MARK

(MADE IN CANADA)

Accurate Pressure Control



Dunham Reducing Pressure Valve Type 310
(This valve has increased outlet)

Dunham Reducing Pressure Valves will reduce the pressure of steam, air, water, etc., to any desired low pressure and hold it at that point, even though there be considerable variation on the high pressure side of the valve. They reduce in one step, without chattering and are very sensitive in meeting sudden demands. They are applicable to a wide range of initial pressures.

Regulation is by means of a lever and weight which is set at the pressure desired. Each instrument has a double balanced inner valve and seats of special phosphor bronze.

Write for complete details.

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OTTAWA MONTREAL CALGARY HALIFAX VANCOUVER WINNIPEG
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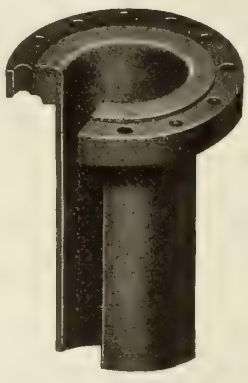
P⊕H FLANGED PIPE JOINTS

SCREWED



P.H. LAP

SCREWED FLANGES.—For general service, our screwed-on flange gives universal satisfaction and is the least expensive. For steam and water lines, at pressures up to 125 lbs., the flange is screwed home and not refaced. For higher pressure, we recommend screwing on the flange until the end of the pipe projects beyond the face, then refacing by taking a cut across the flange and end of pipe, insuring a perfect joint with the gasket bearing on the end of the pipe. This prevents the pressure from working through the thread of the flange, and insures a long life for the joint.

For all High Pressure service, and where it is objectionable to reduce the thickness of the wall of the pipe by threading, we recommend P⊕H Lap Joint.

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Cold Storage Doors
Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

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This 100 h. p. steam turbine driven pump, 3,000 r. p. m., operating against 300 lb. water pressure, has been in operation for **five years** with but one set of "John Crane" Packing. On the 19th day of June, we had to add one ring—not touching balance of rings. The packing now works as though it had been newly installed.

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Style "100"

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Softens, Filters and Heats Feed-Water

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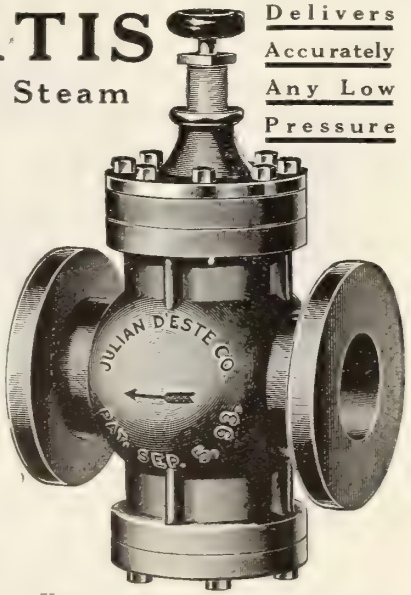
15

CURTIS
Improved Steam Pressure Regulator

Delivers Accurately Any Low Pressure

A compact, self-contained Regulator suitable for any boiler pressure. It delivers accurately and uniformly any lower pressure from one to within a few pounds of the initial pressure.

It has no levers, weights or projections; no glands or packing; no drip or leak of steam or water. Use it for efficient service on steam-heating apparatus, slashers, jacket kettles, air or water pumps, pulp mills, etc.



The Improved Steam Pressure Regulator is a lock valve, very simple and sensitive. Send for descriptive pamphlet.

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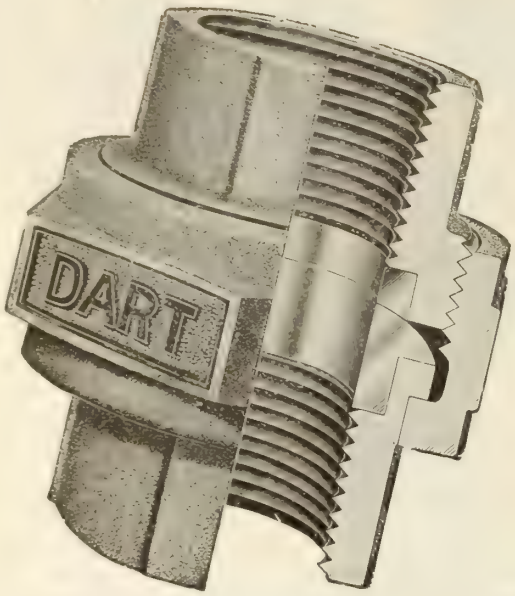

Never Gives Cause For Complaint They Stay Tight Until Deliberately Loosened With a Wrench

THE DART UNION CO., LIMITED
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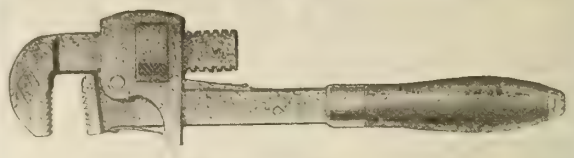
Sold by your jobber



Williams' Stillson Wrenches

Are sturdy and dependable — well balanced—positive in grip—powerful in action.

The tough teeth retain their sharpness; they "bite" instantly, yet release readily.

Wood and Steel Handle Patterns—eight sizes, 6 to 48 inches. Ask for booklet.

J. H. Williams & Co.
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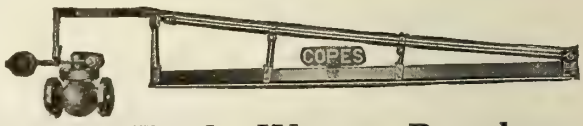
"The Wrench People"

78 Thorold Road - St. Catharines, Ont.

Pressure or Load Changes do not Affect the Accuracy of your COPES



Boiler Feed Water Regulator

A very wide working range is afforded by the simple design of the **COPES** Regulator, which operates on the thermostatic principle.

Not affected by changes in boiler pressure. A high factor of safety adapts the **COPES** to the highest steam pressure used in modern central station practice. Operates efficiently at a working pressure of only 10 lbs.—or more than 300 lbs.

Even if the pressure CHANGES AS MUCH AS 100 LBS., the **COPES** requires no readjustment, but goes on feeding boilers with the same dependability. (Most mechanical feed regulators require readjustment for pressure changes as low as 20 lbs.)

Every COPES is specifically designed for the boiler on which it is to operate. It gives continuous unfailing service, controlling the feed input through the boiler in proportion to the boiler load and furnace conditions. **Automatically, the Copes varies the water level in the boiler, to store excess furnace heat during light loads, and to increase the boiler steam capacity during heavy load demand.**

Our new catalog, just off the press, gives the facts about boiler feed water regulation that you need. Write for Catalog D.

NORTHERN EQUIPMENT COMPANY

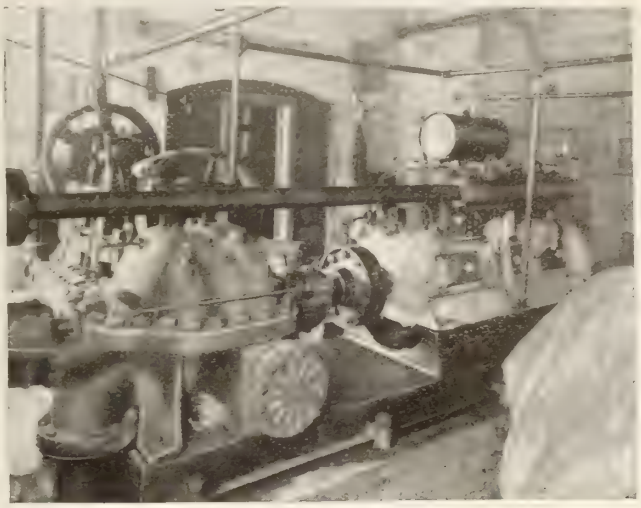
112 West 11th St.
Erie, -- Penn.

Branch Plants: Hamilton, Ontario, Canada; Manchester, England; Paris, France; Cologne, Germany.

EMERGENCY!

A highly developed gasoline engine, costing less than steam to operate, for standby service on centrifugal pumps and electric generators. Costs $20.00 per H. P.

Assures power instantly at low cost.



Six cylinder, 145 H.P. STERLING, direct connected, 2 Stage, Alberger centrifugal 1,000 G.P.M., 100 lbs. pressure, furnished through Reeves & Skinner, St. Louis, Mo. Reserve Pump installed at Marion, Ill.

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40 to 300 H. P. at 1,200 - 1,500 R. P. M.

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Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.

"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility

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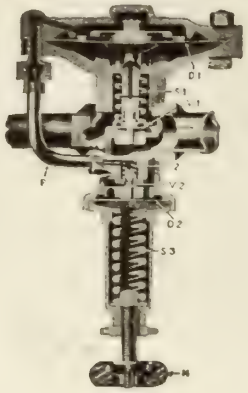


A PRESSURE REGULATOR That is *Different!*

If you need a valve that will shut off absolutely tight when no steam is required on the low pressure side of your steam lines you should use

FISHER
Pressure Regulator
[Series 90]

It is a pressure regulator, **plus**. It not only serves the desired amount of steam to cooking kettles, rendering vats, vulcanizing tanks and other similar processes, but it also shuts off absolutely all supply of steam when these processes are suspended. This conservation of steam pays for the valve in a very short time.

The Fisher Pressure Regulator is a simple valve—all working parts are easily accessible. Highest grade materials and the Fisher standard of workmanship guarantee a long and satisfactory life to the valve.

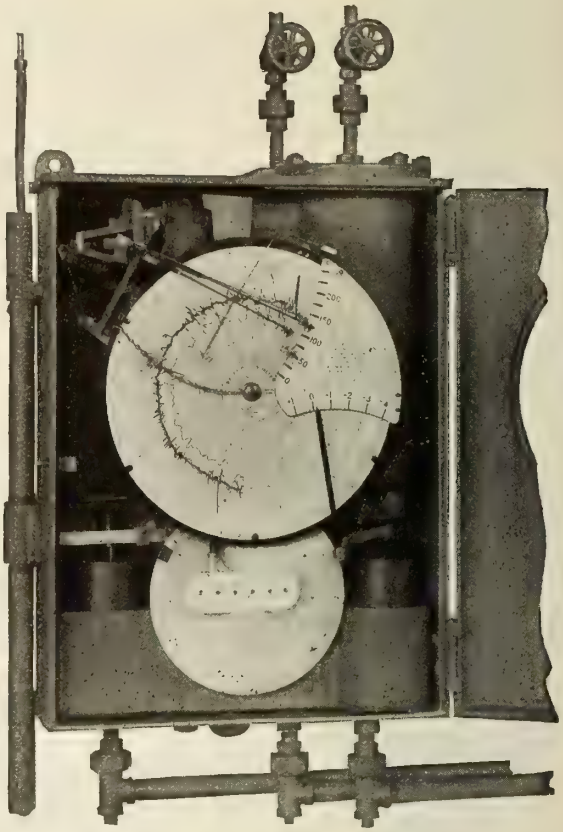
Write for Bulletin 210.
It tells the whole story.

The Fisher Governor Company

935 Fisher Ave., Marshalltown, Iowa

Agencies in all principal cities.

BAILEY
Boiler Meters



IT TAKES a certain amount of air to burn a pound of a given coal. Each pound of such coal when properly burned evaporates so many pounds of water, so that a definite amount of air should be used to generate each pound of steam. Either too much or too little air means inefficiency and causes a lower capacity than otherwise would be the case. Air, therefore, is as much a fuel as coal or oil and a high evaporation per pound of air should be maintained to get the best results.

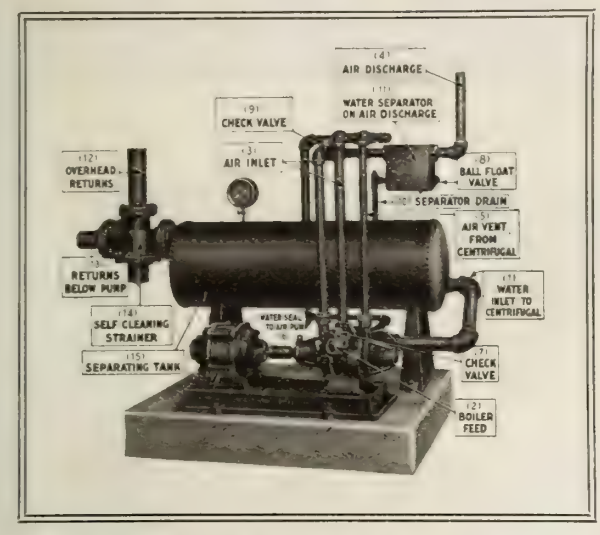
The Bailey Boiler Meter is a reliable guide for the fireman. It shows him exactly what the operating conditions are at every instant so that he can control the steam output and maintain maximum efficiency. It also furnishes a permanent charted record for future reference and study.

Write for bulletins

Bailey Meter Company Limited

177 Delorimier Ave., Montreal, Que.

Jennings Hytor Vacuum Heating Pumps



A saving of more than 50% in horse power

The Jennings Hytor Vacuum and Low Pressure Boiler Feed Pump is without equal for return line heating systems, dryer exhaust systems in paper mills, or other vacuum work where large percentages of liquids have to be handled with gas.

In the Jennings, **the boiler pressure is against the water only.** The air and vapor, representing approximately four-fifths of the volume handled, are delivered to the atmosphere **without back pressure.** The horse-power required to operate a Jennings is less than half that consumed by any other vacuum heating pump of the same capacity.

This pump has many more distinct features—write us for particulars.

THE ARTHUR S. LEITCH COMPANY
LIMITED

1001-2 KENT BUILDING, TORONTO, ONT.

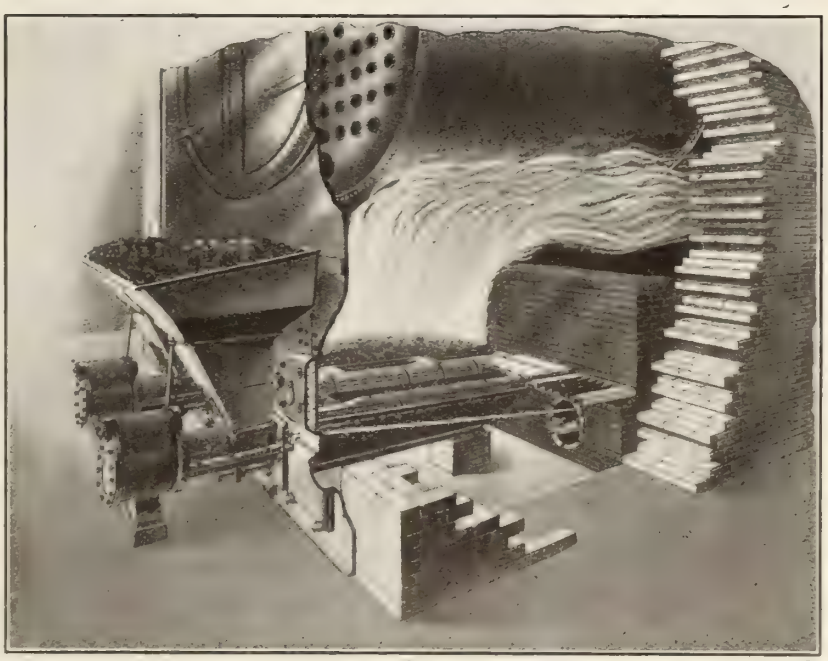
MACLEAN STOKERS

Automatically control the coal feed and air supply to the furnace resulting in complete combustion of every pound of fuel used. Boiler tubes and periods because of the CLEAR COMBUSTION.

The MACLEAN STOKER **will not infringe the smoke regulations** of any city—anywhere!

There are **no grates,** consequently **no siftings!**

Simplicity is the key-note of its construction and the fireman requires no special knowledge of stokers to operate it.



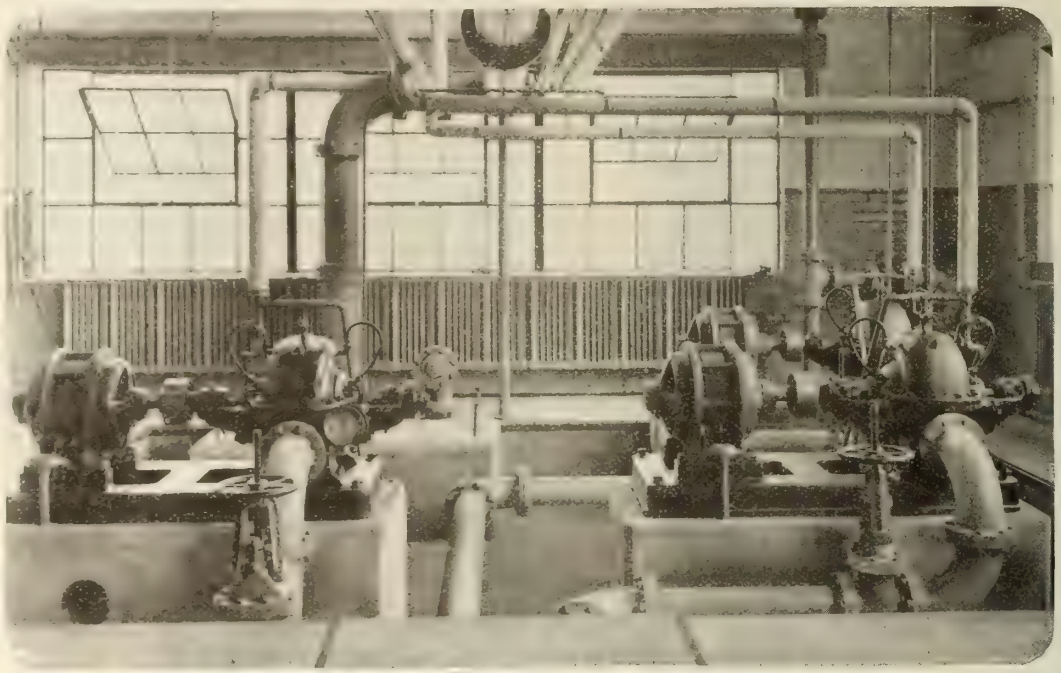
Maclean Underfeed Stoker Co., Limited
95-97 King Street, East,
Toronto Canada

TRADE MARK REGISTERED

THE COAL IT SAVES SOON PAYS ITS COST

GOLDIE & McCULLOCH

DEPENDABLE POWER PLANT EQUIPMENT



PUMPS EQUAL TO ALL EMERGENCIES

THE high efficiency of Rees RoTurbo Pumps makes them the logical choice for any Power Plant. The Match Company, Limited, Berthierville, Quebec, were of this opinion and consequently installed the three Centrifugal, Circulating Pumps shown above. A fourth pump has recently been supplied for this plant.

To Canadian Power Users the name Rees RoTurbo is no stranger. It is immediately associated with the kind of Pump operation that is equal to all emergencies, requires a minimum of attention and never breaks down.

Rees RoTurbo Pumps are of an advanced design and will handle even the **grittiest** liquids with little wear.

Write for catalogues giving complete description of Rees RoTurbo Centrifugal Circulating Pumps, Rees RoTurbo Patent Pressure Chamber Self-Regulating Pumps, Rotary Jet Condensers and Rotary Vacuum Air Pumps.

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POWER HOUSE

Members of the Audit Bureau of Circulations"

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

The Question of Accurate Boiler Tests

This Paper Points Out the Unavoidable Innaccuracies Involved in Reports of Boiler Tests, and the Absurdity of Trying to Estimate Values and Quantities to a Decimal Point.

By ALFRED COTTON

Research Engineer Heine Boiler Co. Read Before the A. S. M. E.

A LARGE proportion of boiler-test reports are presented with heat-balance figures carried to one-tenth and even one-hundredth of one per cent. Those who have had much experience in boiler testing know that such apparent accuracy is impossible at present and therefore misleading. In a heat balance recently published the percentage portion does not add to an even hundred. Since the last item is simply the difference between what is known and 100, why not make it agree? The deviation from 100 makes it appear that the items are very precise indeed.

How accurate is it possible to make a boiler test? To determine this, every item entering into it must be considered.

First consider the measurement of the water. If the water is carefully weighed or measured by suitable meters the amount fed may be ascertained well within plus or minus 1 per cent. If meters are used, they may be calibrated before the test, and perhaps afterward as well to insure this accuracy. Proper precautions may be taken to prevent leaks from blow-off cocks, in feedwater heaters, and so forth. Care can also be taken to see that the condition of the water in the gage connections is the same at the end as at the beginning of the test. If this is not done, error may be introduced to the extent of 1 or 2 in. due to the difference in the weight of cold water in the gage connections before blowing off, and of hot water afterward. With an eight-hour test run at rating, the error may be more than 1 per cent. from this cause.

Quality of Steam—Steam Sampling

Then there is the quality of the steam to be accounted for. The entrained water in the sample can be ascertained very closely, but it is sometimes stated with much greater precision than the observations warrant, or than is necessary. A boiler-test report was seen recently wherein the proportion of water in the steam was given to one-ten thousandth of one per cent.!

The temperature of the steam in the expansion chamber of a throttling calorimeter need only be read to the nearest degree; and when averaging the readings, the result need not be expressed beyond one-tenth of a degree. A glance at a steam table will show that the variation is so slight that carrying it further is futile.

But does the sample of steam so examined represent the bulk steam? That is something which is not known, and the more elaborate discussion given in the complete paper seems to show that it is not even nearly representative.

The design and position of the sampling tube are matters of some contention. It is accepted practice to perforate the sampling tube and place it horizontally across the pipe. It is probable that entrained water is commonly in such small particles that it is easily carried in suspension at usual steam velocities. Water flowing along the bottom of the pipe is likely to be mostly condensed steam, and is therefore rightly avoided by placing the sampling pipe horizontally.

The A.S.M.E. sampling tube is made of ½ in. standard pipe and is provided with twenty ⅛-in. holes arranged in "irregular or spiral rows," and usually in a more or less regular helix. It should be inserted in the steam main "at a point where the entrained moisture is likely to be most thoroughly mixed." The word "likely" is highly commendable.

It is most probable that the design of a steam-sampling device should be some what similar to that of a rain gage; and if this is the case, the A.S.M.E. tube is as unsuitable for its purpose as anything which could well be contrived. One of the fundamental requirements in the location of a rain gage is to avoid the proximity of objects which might shelter the instrument or cause eddies. This requirement is ludicrously violated by the downstream holes in this sampling tube. It would appear that the best position for the holes is directly upstream, and that all holes could be used, placing them at least, say, 3 diameters center to center, and making their total area about equal to the twenty ⅛-in. holes or, say 0.25 sq. in.

The most accurate results would be attained with such upstream holes if the velocity of the steam entering the holes approximated that of the bulk flow along the steam pipe. Then the steam and water particles would enter the holes with the least disturbance of their general direction, and consequently the sample would be most representative.

It seems reasonable to think that the actual water present in the steam may be very much less than that observed when we use the A.S.M.E. tube.

If there is much priming, the error in determining the amount on water carried over may approach plus or minus 5 per cent. of that evaporated. But assuming orderly operation and careful observation, the accuracy of the report on water evaporated may be from plus or minus 1.5 to 2 per cent.; but it cannot well be guaranteed to be closer.

Estimating Coal Consumption

The next item to be considered is the coal, and this may easily be weighed well within plus or minus 1 per cent. However, this is but the coal fed to the furnace, and to know the quantity actually burned in relation to the water evaporated, we must be sure that there is the same amount of fuel in the furnace and in the same stage of combustion at the end of the trial as at the start. The only way to find this out is to look at it. Only those who have done this know how impossible it is to accomplish much more than make a careful guess, and it must be done quickly because conditions are changing momentarily. It is not uncommon for different observers to vary in their estimates to the extent of 10 or even 20 lb. of coal per sq. ft. of grate area. In a test during which a total of 250 lb. of coal was burned on each square foot of grate, the error from this source might amount to over 5 per cent. The error will depend on the length of the test, and for 12-hour tests may very reasonably be placed at not less than plus or minus 1 per cent.

Coal Sampling and Analysis

But, unfortunately, this coal weight does not mean anything of itself. We must at least know the weight of dry coal; and if the moisture present in the coal is much over 2 per cent., allowance

should be made for the heat used to evaporate and superheat it. To find out how much moisture there is in the coal, we must have a representative sample, and then we must analyze it for moisture while it is representative. While working down a laboratory sample the coal will either gain or lose moisture. In a warm, drafty room and especially on a warm floor, it will generally lose moisture, perhaps as much as the equivalent of 3 per cent. of the coal or even more. While it is properly bottled up, no further change will occur; but at the laboratory, while being finely ground and while weighing samples, further change will undoubtedly occur and this may be either in increase or reduction of moisture. During all these proces es of sampling from the coal pile to the laboratory drying oven it does not seem possible to certify the moisture closer than plus or minus 1 per cent. and it may easily be put out to plus or minus 2 per cent. Taking the alternative method of drying the coal during the test, there is difficulty of securing a representative sample, for we are now sampling coal which has not been weighed to the firing floor or hoppers; and there is also the further difficulty of crude drying and weighing apparatus. However, this method is likely to be a little more accurate than the orthodox one, and with reasonable care in selecting samples, results may be obtained within plus or minus 1 per cent.

On examining the report of any boiler trial, the first thing looked for is the efficiency at the trial load. Without this, the report does not generally convey information of very much value. To get the efficiency we must know the heating value of the coal; and whether the heating value is found by calculation from the analysis or by the calorimeter, the essential feature is the extent to which the sample is representative. To fully satisfy this requirement it should have come from widely distributed points in the original bulk coal used during the trial. Of course, this condition is very far from being reached even with the orthodox method of quartering down, unless the test is with powdered coal. Still, such a sample is reasonably representative if the work of getting it has been conscientiously done.

Summary of Errors

It is well here to summarize the possible errors and see where they may lead, and this has been done in the following tabulation, keeping them even lower than suggested.

Coal:	Error
Weighing	± 0.5%
Estimating amount of fuel in furnace at start and stop	± 0.5%
Total error of weighed coal	± 1.0%
Variation between original per-percentage of moisture and that in laboratory sample plus failure of sample to truly represent bulk	± 1.0%
Failure of heat-value sample to present bulk	± 0.5%
Total error in analysis	± 1.5%
Total error in B. t.u. in coal (weight and analysis) on which efficiency is based	± 2.5%
Water:	
Weighing or metering, starting and stopping test, gage glass, leaks	± 0.5%
Failure of sample of steam to truly represent bulk steam as to entrained water	± 0.5%
Total error in water evaporated	± 1.0%

B.t.u. in coal burned may vary 97.5 to 102.5 per cent.

Water evaporated may vary from 99.0 to 101.0 per cent.

Reported efficiency may vary from 99.0/102.5 to 101.0/97.5, or 96.6 to 103.6.

Therefore if the efficiency really attained in any boiler trial is 78 per cent., the report may show as low as 75.4 per cent or as high as 80.8 per cent. if all the errors happen to be in one direction. It may be thought that this possible error is placed at a higher figure than occurs in practice; but it must be remembered that generally the errors will be in different directions and to tend to neutralize each other, and it will be seldom that they are all one way. Consequently if a sufficiently large number of trials are made on the same boiler under the same conditions, some of the tests will nearly alway be found to deviate from the average quite as much as the total possible error here suggested.

If the coal and water deductions are relied on, we know the efficiency and the load. But in view of what has been said it is very doubtful if the regular carefully conducted boiler test burning hand or stoker-fired coal can be guaranteed to be closer than within plus or minus 3 per cent.

The Heat Balance

The heat balance is often considered as a final check on the correctness of the test. A boiler-test report without a heat balance is just as good as the other kind as far as efficiency at load is concerned. But the heat balance confers dignity and precision on the test report because all the items add up to 100 and this seems to prove the correctness of everything concerned in it. However, since it does not "balance" or rather that we make it balance, the term "heat balance" is not without humor. If accountants submitted items in their balance sheets called "unaccounted for" amounting to $5 in every hundred dollars there would be considerable unpleasantness. Of course, a heat balance is different because there is the excuse that no way has been discovered to find out the amounts of some of the items and the others are not as accurate as is generally believed. There is a case of four consecutive tests made on the same boiler by an engineering professor of deserved repute and large boiler-testing experience, in which the "unaccounted for" was respectively 8.7, 0.4, 6.4, and 7.4 per cent. The trials run by Dr. Jacobus on the Delray boilers were among the most careful ever made, and the "unaccounted for" item runs from 1.51 to 4.83—a difference of over 3 per cent. Incidentally, the efficiencies in the series of tests vary over plus or minus 1 per cent. from their average rating-efficiency curve.

The real value of a heat balance lie in the presentation of the various losses and their amounts, and therefore it is more a statement than a balance.

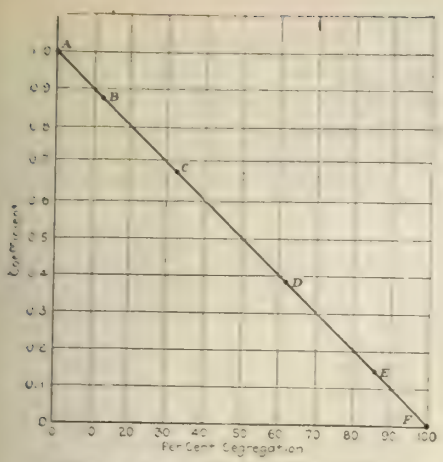
Care has to be taken to get an average sample of flue gas. Its composition sometimes varies greatly across the width of the setting—a much as 5 per cent. of CO_2, according to some experiments, though perhaps some of this variation was caused by the quality of the gases changing rapidly between taking samples. It seems likely that if the gas sample is drawn from some point well within the gas flow, it is fairly representative, for if that were not so, the "unaccounted for" would show a still larger variation that it actually does. This also applies to exit gas temperature, where the radiation effect may affect the readings 50 deg. fahr. With care in placing the instruments the error is perhaps within plus or minus 20 deg. fahr., or about plus or minus 1 in the percentage of heat loss to the stack.

Efficiencies

Even the efficiency as now reported does not provide a proper basis for making trials under different conditions. An efficiency of 75 per cent. with a steam pressure of 225 lbs. is a better performance than the same efficiency at 75 lb. pressure. To be serviceable for comparison, the efficiency should be based on what is theoretically possible in each individual case, and this is governed by the temperature of what is being heated and not by the temperature of the atmosphere.

At first sight it appears that it is not theoretically possible to get the exit gas temperature below that of the boiling point. Therefore the efficiency should be based on perfect combustion with the theoretical amount of air and the products of combustion cooled to the boiling point for the existing pressure. This is not very difficult and the 100 per cent. figure would be set for particular fuel and steam pressure under consideration. The efficiency would be the percentage of the figure attained on the test and might be called the "actual" efficiency to distinguish it from the efficiency as now reported, which might be called the "theoretical" efficiency.

Whether the mean temperature of the water in the boiler or that at the gas exit should be used, is another consideration. In a horizontal water-tube boiler, for instance, the lowest tubes may be 15 ft. below the water level. The added pressure due to this head of water is 6 lb., making a total pressure of 156 lb. when the gage pressure is 150 lb. This increases the boiling point 3 deg., and either the water is hotter at the bottom



Effect of Segregation of Feed Water.

of the boiler or no steam is made there.

The temperature to be used is really dependent upon the extent to which the cold feedwater is segregated. The boiling point may be considered as the proper temperature to use with a boiler in which the feed is so mixed with the circulation that no cold water comes in contact with the heating surface, while with a separate economizer or a flash boiler the temperature of the feedwater should be adopted. But difficulties at once arise with boilers where there is partial segregation. In boilers having integral economizers the feedwater may be wholly or partly segregated. In integral economizers of the Badenhausen type, for instance, there is considerable circulation within the economizer, and the temperature of the water where the gases leave will certainly be well above that of entering water. A somewhat similar condition contains in the rear bank of the Stirling boiler, which is, or used to be, often called the "economizer bank."

It appears, then, that the design of boiler must be taken into consideration and the temperature chosen be that of the boiling point, or of the cold feedwater, or somewhere between these points according to the extent of segregation of the incoming feed. A chart like Fig. 1 could be used and a position on the curve agreed upon for every type of boiler, such as the following:

Pos.	Type of Boiler
A	Horizontal water-tube Scotch marine Horizontal return tubular
B	Stirling with rear circulators
C	Stirling without rear circulators
D	Boilers with integral economizers having free circulation
E	Boilers with integral economizers having restricted circulation
F	Boilers with separate economizers Flash boilers

It is not intended to propose that the positions thus suggested by way of illustration be accepted, either absolutely or relatively. But as an example, with a boiler having 25 per cent. segregation, the coefficient as read from the chart is 0.75. Suppose the boiling point is 370 deg. and the feedwater enters at 130 deg., then the difference is 240 deg., and 0.75 of this is 180 deg. Then 180+130= 310 deg. fahr. which is the temperature to be used.

It might be advisable to make some kind of allowance for the rate of driving, because this would have some effect on the temperature to be used in those boilers having partial segregation of the feedwater.

Probably the simplest way to dispose of the matter is to take the temperature of the water in the boiler at the point where the gases leave, making regular observations during the test. In this way there woud be no contention whatever as to the proper temperature to use. The average of these observations would be recorded in the test report.

The efficiency based on the temperature of the water in the boiler is the only efficiency by which different boiler performances may be intelligently compared. But it must be remembered that the limit of temperature on which it is based is artificially imposed. It may be considerably lowered by the installation of an economizer, and perhaps still more so by apparatus yet to be devised or more generally adopted. When an economizer is added it may be that the efficiency—which will now be based on the feedwater temperature—is lower than before. Of course, this is quite proper because this is really the actual efficiency of the apparatus as a heat generator and absorber. But for the comparison of one steam plant with another or for changes in the circumstances on the same plant such as the addition of the economizer, the efficiency based on the heat value of the coal must be used. Therefore it appears highly necessary that both of these efficiencies be reported in every test. These efficiencies may be stated as:

$$\frac{\text{B. t. u. in steam}}{\text{B. t. u. in dry coal}} = \text{Theoretical Boiler and Furnace Efficiency}$$

$$\frac{\text{B. t. u. in steam}}{\text{B. t. u. available}} = \text{Actual Boiler and Furnace Efficiency.}$$

All comparisons of efficiency are properly based on the load in percentage of the boiler rating. When a superheater forms an integral part of the boiler, the heating surface is greatly increased. The efficiency is greater owing to the increased heating surface reducing the temperature of the escaping gases. But still the efficiency is plotted against boiler heating surface only. This is wrong. The combination should be rated at some higher horsepower than that of the boiler only. It would be a very difficult matter to decide how much to allow for superheating surface as its heat-transfer rate is quite different from that of boiler heating surface. But superheating surface should be rated as the equivalent of so much boiler heating surface.

The same thing applies to economizers. What is the proper way to report a boiler where there is an economizer? I quote from a test report case of unquestionable authority:

Water-heating surface, sq. ft.	4400
Builder's rating, h. p.,	440
Economizer heating surface, sq. ft.	6290
Hp. developed for boiler	1231
Hp. developed for boiler and economizer	1350
Percentage of rating developed for boiler	277
Percentage of rating developed for boiler and economizer	305

What is the meaning of the last item? The one above it is the regular statement of percentage of rating. But the boiler did not develop more horsepower or a higher percentage of rating because there was an economizer near it. The economizer did this extra work—not the boiler. What percentage of the rating of the economizer did the economizer develop?

The steam, or its equivalent when electric motors are used, consumed in driving stokers and mechanical-draft apparatus should always be ascertained and reported as a percentage so that it may easily be deducted from the efficiency by any one suffiicently interested. In testing all or most other apparatus, the efficiency is output divided by input; but in boiler testing we do not know yet how to accurately measure the output. We weigh the water going in and boldly state it as output. Surely the available steam sent away from the boiler is the real output, and if so, all steam used to make the boiler and its accessories work should be allowed for. As conscientious engineers we have always strictly seen to it—and shall continue to do so—that such things as internal-combustion engines, hot air engines and the like shall be tested with a brake so that we know exactly what is their actual output; and the more power they consume in making themselves work, the more for them. But we seem to prefer to avoid telling any one what the real output of a boiler is.

Economizers raise the efficiency by lowering the flue-gas temperature, and they sometimes do this to a point where the gas temperature is too low to produce sufficient chimney draft, in addition to increasing the draft resistance. So an induced-draft fan is used but the power taken to drive it is rarely considered.

The following very imposing array of data is sometimes presented:

Water evaporated, actual, per lb. of coal as fired.

Water evaporated, actual, per lb. of dry coal.

Water evaporated, from and at 212 deg., per lb., of coal as fired.

Water evaporated, from and at 212 deg., per lb., of dry coal.

Water evaporated, from and at 212 deg., per lb. of combustible.

These items are sometimes carried to one-thousand of a pound and none of them mean anything. Any kind of evaporation per pound of coal in any condition is without meaning unless the heating value of the coal is known, and knowing this the efficiency, which is

what is desired, can be easily determined.

In The Engineer (London) of February 25, 1921, H. V. Whittaker suggests basing the evaporation on "standard coal" and he further suggests giving this theoretical coal a value of 12,600 B. t. u. If all tests were reported on the basis of this standard coal we would have a definite standard for the comparison of different performances. But why not go a step further and drop the meaningless evaporation per pound of coal altogether and report the result as B. t. u. in the steam per 100 B. t. u. in the coal? This figure is the efficiency without further ado. There is nothing difficult about it. In calculating the test, the B. t. u. in one pound of liquid is subtracted from the B. t. u. in one pound of steam, superheated or otherwise, and multiplied by the weight of water evaporated. The "factor of evaporation" disappears, and the correction for moisture in the steam is just as easy. The B. t. u. per pound of coal is multiplied by the coal weight and divided into the B. t. u. taken up by the steam. The quotient is readily expressed as B. t. u. in the steam per 100 B. t. u. in the coal. The B. t. u. per hour taken up by the steam is easily converted into the obsolescent "boiler horsepower."

The object of all boiler tests is comparison either with some other test or group of tests or with our general experience, which is the same thing. The report should therefore contain everything which will show the relative arduousness of the conditions under which the test was made, including the variation in loads.

Tolerances

In all manufacturing operations it is realized that nothing can be made absolutely correct. Therefore tolerances are allowed. Whether the suggested plus or minus 3 per cent. for boiler trials considered too large or not, the fact remains that the performance of guarantees is demanded without any tolerance whatever. It is said that if guarantees should carry a tolerance of, say, minus 2 per cent., manufacturers would raise their guarantees by 2 per cent., relying on this margin. If all manufacturers followed this policy they would be on an equal footing and no commercial harm would be done. As matters stand now the prudent manufacturer virtually sets his own tolerance by guaranteeing something less than he knows he can accomplish; while if the proposed tolerance is adopted he can guarantee all he knows he can do, and let the tolerance take care of the testing errors.

There is nothing whatever to be gained by reporting efficiency more closely than the nearest tenth of one per cent. or even the nearest half. Not only is such apparent precision as 1 in 1000 unwarranted by the exigencies of boiler testing; but engineering judgment is quite unable to make use of it. It is mentally impossible to differentiate between the relative values of 79.9 and 80.1 per cent. efficiency and it seems only sensible to call it 80 per cent. Especially is such precision absurd, inasmuch as it is not certain that it was not really 79 or 81 per cent., or even a little further away.

HOW TO SPEND LESS FOR COAL

By W. F. Schaphorst

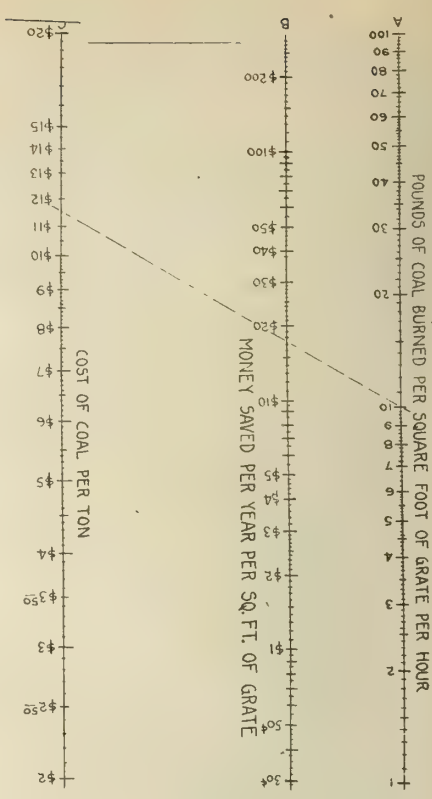
When coal is shoveled into a furnace where does it stop? On the grates of course. Are those grates efficient? Are they designed for the most economical combustion of coal? Are you needlessly burning money on your grates? These questions certainly should not be rudely brushed aside. Grates are worth thinking about because they may be either highly efficient or extravagantly wasteful. That's where you put the coal, in the very first step towards converting it into mechanical energy. That's where it lies through the whole combustion process. We do not take it from the grates and put it somewhere else, as we do other materials in turning out products—it "lives" for a few brief moments on the grate, gives a small part of its life to doing useful work, and also gives a greater share to wastefully heating exhaust steam or atmosphere. After death its remains drop through the grate in the form of ash.

It is therefore plain that the grate has very much to do with the combustion of the coal. That is the place where economy must be effected first of all. I don't know why it is that the grate has practically been ignored by engineers in their efforts for economy in the power plant. It has been pointed out time and again that engineers delight in perfecting engines, turbines, steam lines, condensers, economizers, feed water heaters, and the like, but they keep away from the grate—perhaps because grates are usually so black and dirty. In the process of combustion one can't see any "wheels go round" and mechanical geniuses evidently lose interest.

Every little leak, however, is worth plugging nowadays, and as there are so many big leaks in furnace operation I will dwell on the subject for a moment longer. I have some figures here that should prove of interest.

In a letter from a prominent grate manufacturer he says, "grates will show a saving in fuel of at least 10 per cent. over ordinary plain grates in any case. It has gone as high as 20 per cent. We are willing to guarantee a 10 per cent. saving over plain grates." This statement alone gives us enough data on which to work. What was your coal bill last year? Are you using plain grates? If so, take 10 per cent. of your last year's bill and put most of it in the bank this year by improving conditions. Or, on account of the present high cost of coal perhaps you can "come out even" this year at least.

Getting down to a concrete problem let us say that your plant is a place where coal costs from $11.50 to $14 per ton. Let us assume that you run your



plant 10 hours per day, and 300 working days per year, or 3,000 hours; assume that you burn 10 pounds of coal on your grate per square foot every hour; and lastly assume that the most economical form of grate can be purchased for $5.50 per square foot. How much money would be saved per square foot per year?

There is nothing difficult about the problem. You will readily figure that 3,000 pounds of coal are burned on a square foot per year. If 10 per cent. of this can be saved by installing better grates it is plain that 3,000 pounds of coal would be saved per square foot per year. At $11.50 per ton this amounts to $17.25 per year. That will be the saving at the end of the first year, but it is not the net saving. From it we must subtract $5.50, the cost of the grates, which leaves $11.75 as the saving. Thus you could instal new grates every year and still make good money. If your grate money is 100 square feet you will multiply this by $11.75 to find the total net saving, or $1,175 per year.

To make the computing work still simpler, I have developed the accompanying chart. Simply lay a straightedge across the chart connecting the pounds of coal burned per square foot per hour (column A) with the "cost of coal per ton" (column C) and the intersection with column B immediately gives the saving on expenditures for coal per square foot of grate area per year. From this subtract the price you will have to pay for a square foot of grate and you can decide for yourself whether or not it will pay to make any change. The dotted line on this chart shows how the problem given above would be worked out via the straight-

(Continued on page 28)

Overcoming Heavy Costs of Belt Maintenance

Transmission Problems Should Be In Charge of Competent Man —Inspection Should Be Made Regularly—Importance of Proper Alignment—Lacing of Joints Should Be Carefully Performed

By J. H. RODGERS

BELT dressings are of two types: those intended to prevent slippage, and those used to preserve the fibre of the leather. The most common examples of the first class are perhaps soap or powdered rosin, which the average mechanic uses freely. Dressings in this class are often made of some sticky material dissolved in any oily solvent and scented to conceal their odor. Black belt dressings often have tar or asphalt for the sticky material, kerosene or turpentine for the solvent, and oil of mirbane or citronelle for the odorous constituent. Belts treated with such dressings quickly become coated over and soon both belt and pulley are glazed with a dirty surface that slips worse than before. Selecting a dressing for belts is as important as the selecting of lubricating oils for machinery. Some simple test should be used to see that they do not contain any harmful ingredients. In some fluid dressings naptha or gasoline is used. These are initial preservatives of leather and their presence often indicates other harmful ingredients which are kept in liquid form by them. Since volatile oils evaporate rapidly, dressings containing them have to be applied very often to secure any result.

Destructive Practice

When surface dressing—or as it is often called, the "belt stick"—is freely used. it is not uncommon to see pulleys in the condition shown at F, Fig. 6, where large patches of the dressing cling to the face. As said before a belt derives its power from frictional contact with the pulleys and while the pull from a well "dressed" belt may seem better, the general efficiency has not been increased. This may be made more clear when one realizes the air pockets that must be formed between the patches on the pulley surface. To this must be added the pull required when the belt is leaving the pulley. A stamp may be easily placed on an envelope but some action is required in its removal. At your next opportunity notice a drive of this description and listen to the noise when starting or stopping. Just like pulling a porous plaster from your back.

Detection of Naptha or Gasoline

Naptha or gasoline can readily be detected by putting a few drops of the dressing in the palm of the hand and rubbing it until the mixture warms slightly—the odor will be easily noticeable. If the dressing contains oils of a gummy or drying nature, harmful to the belt, they can be detected by putting a few drops on window glass. If after it is left in a dry hot place for a few days, it feels sticky, or if it becomes dry and forms a crust it would be apt to do the same thing on a belt and should not be used.

Another simple test consists in taking a piece of new leather preferably from the belt on which the dressing is to be used, putting a few drops of the dressing on the leather and laying it on the engine cylinder or steam chest until quite warm. Note the time required for the dressing to penetrate the leather. If the surface is left clean and feels sticky, it indicates that harmful ingredients are present. If all of the sample penetrates the leather, leaving no residue, and the spot where the dressing was applied feels soft and velvety, it indicates a good dressing. Common examples of the second type of dressing —intended to preserve the leather—are neatsfoot or Brockton oil, castor oil, and dubbib (a mixture of cod-oil and tallow). These, properly used, will keep leather belts thoroughly pliable, mellow and sufficiently greasy to have the maximum co-efficient of friction. These dressings penetrate the leather and depend for their effectiveness on their action on the leather, while the sticky dressings remain largely on the surface.

The use of sticky dressings often results in pulling the laps apart and peeling off the grain of the leather because of sticking of belt to pulley by the dressing; overstrain of leather due to the use of belts of inadequate size, made to carry overloads by use of such dressings; uneven frictional contact and belt strain due to accumulation of lumps of dressing and dirt on pulleys and belt —actual damage to the leather fibre from components of dressing and from excessive slippage. When a leather belt is slipping badly, because it is not tight enough or because of sudden overload, it may be permissible to use a little sticky dressing. For the continued use of sticky dressings with leather belts there can be no excuse and with the right belt no need. Practically all belt dressings of the second class cause a slight temporary increase of slippage at the time of application—the amount of this depending on the amount of dressing used and on the rapidity with which it is absorbed.

The best time to apply dressing is when the belt is idle and can stand for some time so that the dressing can penetrate into the leather. Penetration is assisted by warming the dressing also. When it is not practicable to apply dressing to the belt while idle, a piece of burlap or waste covered with dressing may be held to each surface of the belt while running and a thin film of dressing be deposited in this way on the leather. The fundamental requirement is to have a clean leather surface to which to apply the dressing. It is worse than useless to put dressing on a belt already covered with dressing, or with dirt or oil. Therefore, remove all excess dirt by means of some form of scraper. A sharp-edged block answers the purpose very well. Then, if necessary, scrub with naptha or kerosene but whether by this or some other method, be sure of a leather surface that you can recognize as leather. Put a little

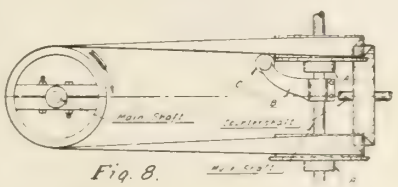


Fig. 8.

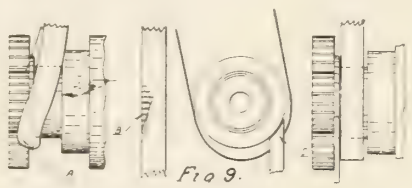


Fig 9.

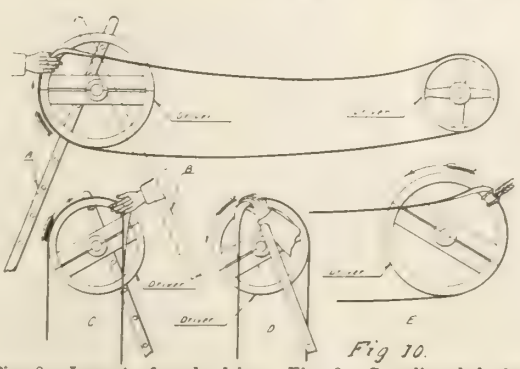


Fig 10.

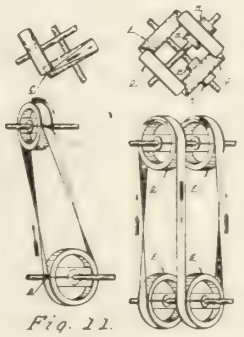


Fig. 11.

Fig. 8.—Layout of mule drive. Fig. 9.—Guarding belt from drive gears. Fig. 10. Placing belt on pulley. Fig. 11—Quarter turn drive.

This article was prepared from material supplied by the Saddler and Haworth Co. and the experience of the author. First part appeared in the June 15 issue.

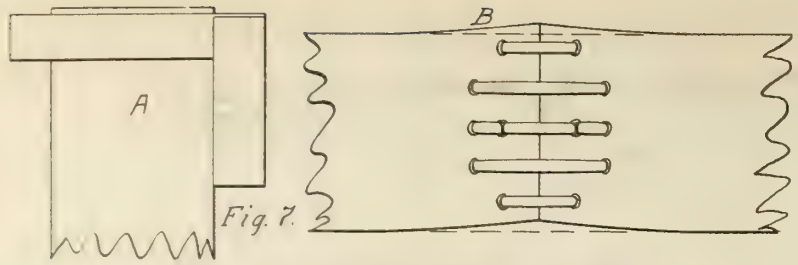


Fig. 7.—A, belts should be cut square. B, result when ends are not cut square

dressing on the driving surface, and more on the surface away from the pulley. A proper dressing will gradually work its way through the leather, and give the driving surface the necessary lubrication, causing it to have that mellow feel, readily recognized by the expert belt man. Probably the best way of doing this is to rub the belt all over with a piece of burlap covered with the dressing, having steadily in mind that too much dressing is apt to be more harmful than too little. No free grease should be apparent on the driving side of the belt after the dressing has been applied.

How To Treat New Belts

Mechanical tests show that the ordinary new belt will not carry the same load as it will after a few weeks service, by from 10 to 20%. It follows that on new belting a good light coat of dressing should be applied in the manner suggested above—before installing. Repetition at frequent intervals for the first few weeks would help, too. Remember that dressing is not put on the belt so that it may stick the belt to the pulley and thus make it pull more. It is put on so that by entering the leather fibres it may toughen them, lubricate them, and thus give longer life to the belt. When ever the leather seems dry, harsh, tinny, does not have the right mellow feel—you may be sure dressing should be used.

Another important factor in belt economy is cleanliness, first of belt and then of pulley. A clean, soft hand will not slip easily even on smooth glass or polished wood. Leather was once skin, and smooth, clean leather will not slip easily on a smooth, bright pulley surface. Belt surface should be clean, smooth, level and comparatively dry. Tests have shown that the coefficient of friction (on iron and steel pulleys) is: .56 when dry, .36 when wet, .23 when greasy, .15 when oily. Therefore it is very important that both belt and pulley be kept as dry and clean as possible.

Too much grease is injurious to leather. Mineral oils in particular rot leather rather rapidly, and where belting is liable to become soaked with oil, mechanical means should be taken to keep the oil from the belt. Where mechanical protection is impossible, the belt should be removed from time to time and the oil extracted with some solvent such as naphtha or carbon tetrachloride.

Packing the belt in dry sawdust or shavings will sometimes answer the purpose. If it is impossible to remove the belt, wiping on the pulleys with a dry cloth or waste will help. Machine oil, in addition to its tendency to rot leather, when present in excess gives a very poor friction surface, as shown in the table preceding. Too much oil will penetrate the belt and affect the adhesive quality of the ordinary cement used in gluing belts together. Frequently, from this or other causes laps start up at the points, a result sometimes due to running belting in the wrong direction.

Direction of Travel

Another point that comes under discussion in connection with leather belts is that of the spliced joints, and their relation to the direction of travel. It is quite evident that the thin edge of the lap may show signs of parting after a period of service. For this reason some men contend that the belt should be run with the splice as shown at B, Fig 1. On this principle the action of the pulley will aid in keeping the thin edge down to its place. On the other hand, some belt men say that the action of the air on the belt surface when in motion tends to lift the edge from its place. As this air action is greatest when the joint is passing around the pulley it would appear that the subject is open to discussion. However, as slow running belts are not subjected to excessive air action it might be said that the method shown at B would be best, and that at A best suited for high speed belts. Irrespective of the advantages claimed for either method, the entire question seems to be one of careful attention in the matter of repairs and maintenance so that faults may be remedied as soon as they are observed.

Avoid Small Pulleys

In double or three ply belts these splices can be run to meet both conditions as shown. In the use of double or triple belts for heavy power drives, care should be taken to use pulleys as large as possible, consistent with speed requirements, as effective heavy drivers are impossible on pulleys of smaller diameter. This is quite clear when we consider the lack of flexibility of the heavier belts. Running over small pulleys also tends to create a fault as shown at G, Fig 1, when the ply of the belt may be loosened.

A condition that sometimes arises in the case of old style lathes is that shown at Fig 9 where the belt will jump the flange and get caught in the gears. A guard will often eliminate this trouble.

Remember that because shafting was in line once it does not necessarily remain so indefinitely, and regular attention to this point will result in a large saving of time, trouble and power. Light machines, especially when not firmly fixed to the floor, are apt to get out of line a little. This misalignment is difficult to detect and always results in uneven belt strain, excessive slip and reduced delivered power.

The Mule Drive

Another drive that is occasionally used is that illustrated in Fig 8. This is known as the mule drive and is adopted where a machine is to be operated at right angles to the line shaft and where a quarter turn drive is not permissible. In the mule drive the connected shafts usually lie in the same horizontal plane, invariably at right angles, where the prolongation of the counter shaft would intersect the main shaft. The intermediate pulleys revolve in a horizontal direction on a vertical shaft. When it is desired to run the belt in either direction it is advisable to have the two main pulleys of the same diameter Collars are necessary on the vertical shaft to support the pulleys. One bad feature in a mule drive where the load is a fluctuating one, is the tendency of the belt to run off the mule on the slack side. It is preferable to have the pull come in the lower side, but in either case the slack side should be provided with a guide pulley C, carried in a bracket B fixed to the mule shaft. This will aid in supporting the belt when the load is on the machine.

Proper Position of Ladder

When placing a belt on the pulleys it should first be located on the "dead" or driven pulley, as shown in Fig. 10, the actual running on of the belt being done on the driving pulley. As the latter is usually on the main shaft, in the majority of cases a ladder is necessary, and in placing the ladder, care should be taken to locate it on the outside of the drive, as shown at A. With the exception of special cases, where the drive shaft is located along a wall, the ladder should never be placed in the position B, and when such is absolutely necessary the shaft should be stopped and the belt run at a very slow starting speed.

When standing on a ladder for this work the body should not be in a strained position, and one hand should be placed on a fixed object for support. For the lighter sizes of belts it is seldom that the speed of the driving shaft is reduced, as the knack is soon acquired of running the belt on. On the heavier belts the work is more difficult, but dexterity is attained with practice. When the belts are very heavy or extra tight, or with a load on the belt, "snapping on" is not so easy, and slipping of the belt is often necessary, while speed is accelerating.

Periodical Overhauling Advisable

To make certain that you are getting

(Continued on page 24)

Some Notes On The History of Insulation

The Use of Protective Covering From the Dawn of History to the Present Day is Briefly Outlined in This Article, and the Origin of 85 Per Cent. Magnesia Explained

By T. W. CAVEN

NATURE has given all animals a protective coat against the elements. This coat is of such a nature that it either keeps the heat of the body from being dissipated so rapidly that life cannot be sustained, or such that it keeps the sun's rays from becoming unbearable. Animals living in cold climates are given the most efficient heat insulation found in nature—hair and a thick layer of fat.

In the dawn of civilization man learned that in order to stand the cold it was necessary for him to have some other kind of a protective covering than that which nature had given him. In looking for one, he took that which was nearest and easiest to obtain—the skins of the animals which he had killed.

He first wore the skins of animals as a protection against the elements. The hair was worn on the outside as an ornament in most climates, but in the winter it was worn on the inside, as the aborigine soon found it was much warmer. Of course, the air cells of the hair give the best protection. The more fortunate, or rich—if we may call them such—wore the finest or softest skins since these were warmer. This was due to the greater number of hairs in a given area. Little did the savage think that he was applying the fundamental law of thermal insulation that the greater the number of air cells to a given space, the better the insulation.

Man living in tropical climates seldom clothed himself in furs. He used instead garments of grass or the fibres of plants, to protect himself from the hot rays of the sun.

The first mention of a material used for heat insulation is found in the works of Herodotus. He speaks of seeing brick which floated. They were used by the Romans to put behind marble slabs to keep the heat from being lost by radiation. Some of these bricks have been found in the ruins of the baths of Rome. We now know that they were made of infusorial earth found in the northern part of Africa, where the same kind of material is being mined and used for the same purposes to-day.

A large number of the early writers speak of the use of infusorial earth for the purpose of keeping the heat in chimneys so as to give better draft and to decrease the soot that forms on cold surfaces. In all references they call attention to the fact that brick made of this earth are much lighter than those made of other earth (clay).

Insulation of Steam Engines

James Watt, when he made the discovery that the cylinder of a steam engine should be kept as hot as possible, put wood around the cylinder to keep the heat from being carried off too rapidly This practice was followed up to a very few years ago, as low pressure steam was used and the heat was not high enough to cause the breaking down of the wood.

Count Rumford is given credit of being the first to mention the use of diatomacious silicia as a heat insulating material. He used it about 1790 in the construction of fireless cookers which he had made at the time he was feeding the poor of Bavaria at public soup kitchens. It was due to his discovery that the fireless cooker is so widely used in Europe at the present day.

Authentic data and dates as to the use of heat insulating materials, from this point of time, are rare and of little value. However, with increased pressure of the steam used for power, it became necessary to reduce the loss due to condensation to a point where the loss was not greater than that gained by the higher pressures. Also, since it was necessary to have the steam lines of greater length than had been thought possible in the past, some way had to be found to stop the loss due to condensation in the pipe lines.

The First Scientific Insulation

There is little queston that hair-felt was the first material to be used for insulating heat surfaces. This was due to the fact that wool was the best insulating material then known to man. The use of felt was, in all probability, discovered by some one who had a steam pipe exposed to the weather so that in cold weather the steam condensed to such a point that only water came through. No doubt wrapping the pipe with a piece of wool cloth was tried; and as the condensation was stopped, it was but a short step to a hair-felt covering, since this material was much cheaper than woven cloth.

Felt is an excellent insulating material where low temperatures only are to be taken into consideration, but owing to its poor heat-resisting qualities, it is of no value for temperatures over the point where the material breaks down. It has the lowest conductivity of any of the commercials in use, and is used largely in the insulation of cold storage plants where a flexible material is required.

Cork, flax, wood, and other vegetable materials have been tried but with poor success, because of the low breaking-down point of the material. This causes dry rot or carbonization.

Cork is at present one of the most universally-used materials in the building of cold storage plants. It has low thermal conductivity and light weight, and will resist the action of water better than any of the natural materials. The cost is largely in its favor as its application is easy. The usual method is to use it in large sheets or blocks.

Prejudices Against Insulation

At one time in the last century the advisability of insulating boilers or steam pipes was a question. Writers of that period said that if the surfaces were clothed, the surfaces would rust to such an extent that boilers would be very dangerous; also that the upkeep on steam lines would be greater than the saving. It is hard to believe that less than half a century ago what is known to-day as modern heat insulation was unknown. High pressures of 100 lb. to 300 lb. were thought to be impossible, and superheat was not even considered.

Pipe and pipe boiler coverings there were, of course, Many strange combinations of materials, such as lath and plaster, lasters filled with wool of sheep, plaser filled with slag, straw, cnaff, hair, and vegetable fibres were given in some of the works on the handling of steam plants.

In 1883, Prof. J. M. Ordway, of Boston, made for the Mutual Fire Assurance Companies of Boston, a series of tests as to the origin of a number of fires resulting from "spontaneous" combustion of pipe and boiler coverings. We read in his report a list of coverings which, to say the least, are strange. Here are some of them:

Slagwood in wooden cages covered with burlap or cloth.

Asbestos fibre, then asbestos paper, then hairfelt, then cloth.

Clay, then paper, then hair-felt, then lath and plaster.

Fossil meal, plaster with hair, cloth covering.

Many other combinations are mentioned and some of them are forerunners of some of the best coverings on the market to-day.

Some of Ordway's tests are interesting. He found that "rice chaff moistened with water glass was more efficient than straw rope." When he stated that fibrous or porous matter acts mainly by virtue of its entrapped air," he struck the keynote of modern insulation, but as we find no mention of it anywhere else than in his report, it is hard to believe that he realized the great importance of this statement or that any one else saw anything in it.

Professor Ordway was one of the first to recognize the importance of sectional pipe covering for pipes after they had been installed. He recognized the ease of installation, and, in case of repairs,

the ease with which it could be taken off the pipes without too great a loss when replacing.

In 1884 Professor Ordway stated that "at first sight it may seem as though magnesium is too costly to be taken into account, but there is nothing but the lack of demand to hinder a very economical production of magnesia alba."

Origin of 85 Per Cent. Magnesia

In 1885 H. M. Hanmore, a practical pipe-coverer, began to use magnesia carbonate with his covering materials. He consulted with Dr. R. W. Mattison, who at that time was a large manufacturer of magnesia products. Dr. Mattison saw the possibilities of magnesia as he had been having trouble with his drying room because the magnesia powder settled on the steam pipes and cut off the heat. The doctor was not an engineer, but took advantage of Hanmore's suggestions, and after many experiments, developed what is now known as 85 per cent. magnesia.

It was about this time that the question came up as to whether the covering of boilers and steam pipes was advisable. There were many arguments pro and con, and even as good an authority as Roper was in doubt as to the advantage of it. He states in his handbook, published in 1892, on Clothing Marine Boilers, "Although it must be allowed that in all cases the clothing of marine boilers with non-conducting substances, such as hair-felt, wood, etc., is highly advantageous for the production of steam, yet this practice is alleged in some instances to have induced a rapid wear in the plates of the boilers. This unlooked for result is most apparent in boilers which are frequently used and disused alternately, the corrosion taking place on the interior surface."

It is hard to realize that such theories could have been held at such a late date as the above, but when we consider that even at this time there are a number of engineers who raise the question of damage to the furnace walls in case insulation is used, it is not hard to see why so many years passed before there was any serious effort made to work out the problems of insulation.

Nineteen hundred two saw the first effort to get any basic facts in regard to what insulation meant to the plant operator. That effort was the first ste toward finding what the cost was and what profit could be expected from the investment. It was made by Henry M. Scott, who made tests of what was at that time the largest steam plant in the world, that of the Manhattan Railways Co. His conclusions as to the items to be considered are most interesting and can hardly be improved upon to-day.

They are:

Investment in insulation.

Cost of coal to supply lost heat.

Five per cent. interest on capital invested in boilers and stokers rendered idle through supplying lost heat.

Guaranteed life of covering.

Thickness of covering.

Scott decided on magnesia as being the best at that time. His method of making the test was very interesting, as it was the forerunner of the present method of making tests of insulating materials, did away with the uncertain methods of the past and brought into use methods which deal only with known facts. We will see later what these facts mean and why they are used.

It is too bad that Scott did not give us some report on the state of the art in Europe at that time, as the Germans had gone to the point of bringing out a very efficient insulation in the shape of brick and covering made from kieselguhr. Had Scott made any investigations of this material they would be of great interest at this time.

So much for the general history of insulation in the past. There were many investigators who made a very exhaustive study of the thermal conductivity of materials, but it seems as though they did not take into consideration any commercial or practical value of effecting a saving in fuel. They were interested only from the scientific standpoint.

We can take up any standard work on the transfer of heat and find any number of references made to the work of men as far back as the early part of the 18th Century. It is rather strange, then, that all of the work which had been done on this subject was allowed to lie dormant so long and that it is just now being brought to a point where we are realizing the fruits of all the endeavors.

OVERCOMING HEAVY COSTS

(Continued from page 21)

the most of your belts and to safeguard against the possibility of a sudden shut-down in some department on account of belts going wrong, have all been overhauled periodically. Have greasy belts cleaned up. Have the splices looked over and the laps that have picked up carefully cemented down agan. Have worn out belts cut down to a narrower width and use them over again. In this article we have briefly indicated several ways to keep belting equipment in trim. To summarize: Place a responsible man in complete charge of all transmission equipment; standardize belting as to type, brand, width and weight for every drive; demand regular inspection and reports as to condition of belts; run belting at a uniform tension and as slack as possible; eliminate injurious dressings and use a little good dressing; keep pulleys and belts clean and smooth; make sure that shafts and pulleys and belts are in constant alignment; overhaul belting periodically. If these suggestions are faithfuly adhered to it will mean less power used, less work for mechanics and millwrights, uninterrupted operation of machines, increased output, lower cost of power transmission, and more profits for the firm.

MONO CORPORATION CHANGES

The C. J. Tagliabue Mfg. Co., has taken over from the Mono Corporation of America the manufacturing and selling rights of their entire line of Gas-Analysis Instruments for use in the control of combustion and industrial furnaces.

In addition, Mr. F. D. Harger, general manager of the Mono Corporation of America and associated with Mono interests since 1914, has entered their employ, enabling them to render expert service on all questions of combustion with aprticular reference to Mono installations.

STEAM HEATING

One of the most complete treatises on the subject of steam heating that has ever been published, has been compiled and issued by the general engineering committee of the Warren Webster & Co., N. J.

The information in the book is of a very authoritative nature, having been entirely based on the practical experience of the firm, in their long connection with this industry as manufacturers and installation of steam heating appliances. The book is divided into two parts, the first covering the theory and practice of steam heating in a most complete manner, while the second part is devoted to a detailed description of Webster heating appliances, and their application to various installations. This book should take its place in the literature of the subject as one of the most important contributions yet made. It is published at $3.25 net..

HYDRO ELECTRIC INSTALLATIONS

The citizens of the town of Thessalon have given their consent to a by law authorising the construction of a municipal hydro electric plant, of 200 K. V. A. capacity. There will be 3½ miles of transmission line. A centrifugal, motor driven pump will be installed for water works service, and in addition to this a gasoline engine driven pump will be installed for fire purposes. The plant is expected to be in operation by September 1st.

There have been several newspaper reports to the effect that an American concern have been successful in securing options on the stock of the Canadian Locomotive Co., Kingston, Ont.

Canadian Machinery wrote direct to Wm. Casey, vice-president and general manager of the Canadian Locomotive Works, asking a definite story regarding these reports, and following is his answer:

"With reference to newspaper clippings stating that the Baldwin Locomotive Works is seeking control of this company, I would state that there is nothing true in this information. It is only one of many rumors that have been started by irresponsible parties in Kingston without consulting the officials of the company."

Air Transformer Shows Remarkable Efficiency

New Meaning to the Term "Free Air"—Low Consumption of Compressed Air—Big Saving Effected—Strainer Retains All Dust and Dirt

By D. M. McLEAN, E.I.C.

REMARKABLE savings are being shown by a new device for blowing forge fires and similar purposes recently introduced in Canada. A tiny jet of high pressure air discharges into a bell mouth nozzle leading to the forge and induces a flow of air from the atmosphere into the nozzle where it mingles with the expanding jet and is propelled into the pipe leading to the forge, providing the proper volume of air at a suitable pressure for the purpose.

In present practice, in boiler shops, blacksmith shops, steel erection, ship yards and certain chemical and other processes, it is customary to take compressed air from the general supply line and throttle it down to a pressure of a few ounces before it reaches the forge fire. In rivet heating, for example, the ordinary small portable forge will require about 45 cubic feet of free air per minute to blow the fire. To compress this to the initial pressure of 100 lbs. will take the expenditure of approximately 7½ horespower. In constant daily use, this may mean a yearly cost for air from one forge of at least $300.

With the new blower or air transformer, made by the Ingersoll-Rand, and described below, the consumption of compressed air from the supply line is less than 2 cubic feet of free air per minute, requiring practically one-third of a horespower, because the other 43 cubic feet required for the fire is drawn from the atmosphere. This represents a saving in dollars and cents per year per forge, other conditions being equal, of not less than $275 per forge. The term "free air," therefore, takes on a new and very important meaning.

The chart, Fig. 1, shows graphically the results of three tests of forges operating with and without the blower. The space between the upper and the lower curves indicates the greatly lessened drain upon the compressed air supply, and the consequent savings are expressed in percentages at the top of the cut.

Test No. 1 was taken with a slow fire, No. 2 with a fairly hot fire and No. 3 with an intense fire. These percentages may also be considered as expressing the efficiency of the blower under the varying conditions, and they emphasize unmistakably the futility of the common practice of compressing the required quantity of air to a pressure of 80 to 100 lbs. and then throttling it down for use at a pressure of a few ounces.

These tests were taken with partial needle valve openings and consequent reduced pressure on the jet nozzle. The results of tests with the blower connected to an orifice tank with low pressure nozzle on the outlet to furnish resistance to draft and measure the output are shown in Figs. 3 and 4.

Fig. 2 shows the general arrangement of the device. V is an ordinary needle valve regulating the flow of compressed air. In ordinary operation, one quarter of a turn usually provides sufficient air for the work. After passing through the strainer S which retains all dust and dirt which might clog the device, the air reaches the special nozzle N and is discharged into the bell mouth B which is connected to the forge.

The bell mouth is cast solid with the strainer chamber, and ample space is provided for access of atmosphere air as it is drawn into the bell mouth. The strainer may be easily blown out by removing the plug at the bottom of the chamber. Home-made blowers resembling this device have often been made up from pipe fittings, but cannot attain anything like the results reached by this

Working Pressure on Jet Nozzle lbs. per sq. inch	High Pressure Air Used C.F.F.A. per minute	Low Pressure in Inches of Water	Free Air Delivered C.F.M.	Per Cent. of Air Induced
5	.96	.31	12.15	92
10	1.36	.72	18.5	92.8
15	1.67	1.00	21.8	92.3
20	1.93	1.25	24.4	92.2
30	2.52	1.84	29.6	91.5
40	3.07	2.38	33.6	90.8
50	3.64	2.87	36.9	90.2
60	4.20	3.14	38.6	89.2
70	4.75	3.61	41.4	88.7
80	5.3	4.12	44.2	88
90	5.85	4.57	46.5	87.5
100	6.45	5.05	49.0	87

With a 1 in. orifice the New Jersey Blower develops pressure or draft in excess of ordinary requirements for blowing forges. When pressure or resistance against which the Blower delivers is increased, this is at the expense of volume and also reduces the percentage of free air induced. The normal outlet of the Blower is 1¼ inches, giving a greater volume at a little lower draft pressure.

Working Pressure on Jet Nozzle lbs. per sq. inch	High Pressure Air Used C.F.F.A. per minute	Low Pressure in Inches of Water	Free Air Delivered C.F.M.	Per Cent. of Air Induced
5	.96	.29	18.3	94.8
10	1.36	.48	23.6	94.5
15	1.67	.67	28.0	94.0
20	1.93	.88	31.9	94.0
30	2.52	1.29	38.6	93.5
40	3.07	1.64	43.5	93.0
50	3.64	1.95	47.5	92.4
60	4.20	2.18	50.5	91.7
70	4.75	2.50	54.0	91.4
80	5.3	2.80	57.0	90.6
90	5.85	2.95	58.5	90.0
100	6.45	3.25	61.4	89.5

The resistance to flow or draft pressure required in an ordinary forge is somewhat less than for a nozzle of this size. With less resistance the flow is greater in volume. The working pressure on the jet is controlled by the needle valve and can be anything up to the full line pressure. In forge blowing the working pressure required is usually from 15 to 40 pounds and draft pressures of ½ in. to 1 in.

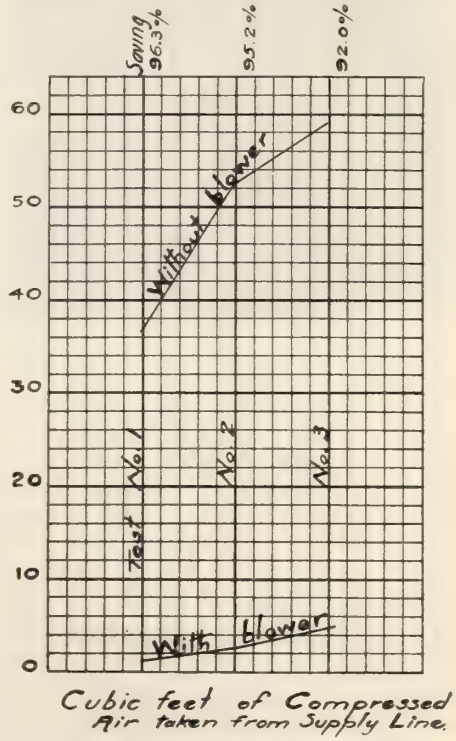


Fig. 1.—Test Shown Graphically

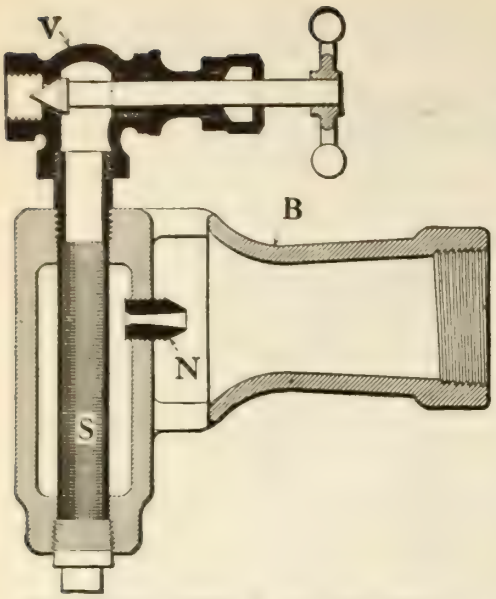


Fig. 2.—Cross section of new forge blower or "Air Transformer," showing arrangement of various parts.

specially designed appliance, proportioned and adjusted for the best possible work. The standard blower of this type is designed to deliver the air at a pressure of 4 inches of water, but higher pressures may be reached by the use of specially designed jet nozzles.

In the tests mentioned above the actual air pressure in the screen chamber

Fig. 5.—Installation of Blower.

below the needle valve was taken. This is the same as the working pressure on the jet nozzle. The cost of this device is such a small fraction of the saving it secures, it may be expected to have quite a wide application in its particular field.

The great value of high speed steel is due to its quality of holding its hardness when cutting at a rate of speed and feed which heats the point of the tools to a red or higher heat, and also the greater length of time the tools will stand up to the work without regrind-

THE ROTASCOPE

The National Physical Laboratory, which was established near London by the British Government, has produced quite a number of scientific instruments of the highest value. One of those was recently shown at a scientific exhibition in London. Its purpose is to render a rotating object continuously visible while it appears to be at rest. The method adopted is different from that of illuminating the object by a series of brief flashes of light. The principle made use of is a property of reflection from a smooth surface which is rotated round an axis parallel to the surface and in line with the axis of the object. When this reflecting surface is rotated at half the speed of the object itself, the image in the reflecting surface appears stationary. This instrument is expected to prove useful for measuring speed and for studying the phenomena of vibration and strain in rotating objects.

HOPES FOR ALCOHOL FUEL

From the scientific point of view alcohol is an excellent fuel for motor cars and other machines driven by internal combustion engines. In view of the importance of the subject, Great Britain has organized careful research not only into the uses of alcohol of different strengths and in different types of engines, but into the possibility of finding some source of alcohol which will be cheap and abundant. This research is being assisted by a Government grant, and it has already produced some highly interesting results. The efficiency of fuel alcohol is in fact higher than that of either petrol or Benzol. A new series of experiments is now in hand with a view to investigating the influence of ether on alcohol and also the influence of alcohol mixed with petrol, benzol, paraffin and other familiar oils. In connection with the fuel question it is interesting to note that discoveries of oil deposits have rewarded the patient investigation which has been carried out for some time in Great Britain. In one part of Scotland oil has been met with at a depth of over 1,800 feet, and the oil is stated to be of excellent quality with a high percentage of petrol, kerosene and lubricating oil.

WHAT IS THE "TRANSVERTER?"

One of the fundamental problems for the electrical engineer is to change alternating current into continuous or direct current. This change has to be made for a variety of reasons; and it is exceptionally important in the case of electric railway working, where many engineers advocate the use of direct current at very high pressure. Two British engineers have been devoting their attention to this matter and have devised a machine which provides far and away the most efficient means of producing high pressure direct current from the alternating current generally produced by steam turbine-driven electric generators. It is impossible to describe this machine without elaborate technicalities, but we may state that the first machine made, which has been under test successfully for about fifteen months, changes alternating into direct current at 100,000 volts with an efficiency of about ninety five per cent. The original design was so excellent that subsequent tests have not led to any material alterations. This machine, which is called a "Transverter" because it first transforms and then converts the current, is expected to be of immense value in the electrification of railways and also in the linking-up of electric power stations which is so necessary to economy in the public supply of electricity. This machine may therefore be regarded as having passed through the experimental stage. Machines with an output of over 700 horse power are expected to be at work in the near future.

CATALOGUES

The Jos. W. Hays Corporation, Michigan City, Ind., have issued a folder describing their "Bestix" cement for boiler settings. The folder contains information on air leaks and their effect.

A book of operating instructions for the Hays Automatic CO_2 and Draft Recorder has been issued by the makers, the Jos. W. Hays Corporation. It shows the construction in complete detail, and gives advice on the packing, setting up, and operating of the instrument. Illustrations of typical installations are also shown. The book should be in the hands of every engineer who has one of these instruments.

A well illustrated, strongly bound booklet describing the Gray System of automatic combustion control has been issued by the Automatic Fuel Saving Co., of Philadelphia and Chicago, represented in Toronto at 71 King St., W. The book describes the apparatus in detail, and with plenty of illustrations. The controller not only regulates the steam pressure by manipulating the chimney damper, but maintains a constant over fire vacuum regardless of the depth of fuel bed, or extent of main damper opening. Thus the over fire vacuum is maintained a constant quantity, while the air necessary for combustion may fluctuate between a maximum and a minimum according to demand.

* * * *

The McAlear Mfg. Co., 1901-7 S. Western Ave., Chicago, Ill., have ready for distribution a new 128 page catalogue, known as No. 27, which illustrates many new devices, including an Individual Temperature Control Valve, Specialties for all Power Plants, Vacuum and Vapor Heating Systems, Oil Refining and Water Works Plants, Plumbing Systems and Marine Service, together with illustrations showing their application and use.

The Individual Temperature Control Valve is self contained and can be applied to any radiator, old or new, without additional piping other than the supply and return.

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The Fuel Outlook

THE COAL strike in the United States fields, upon which industrial Canada depends so largely, still continues, without any tangible sign of betterment. There have been several tragic and disgraceful episodes, and these have been passed over with but little comment, or as far as can be seen without any endeavor to punish the ones guilty of aggression. As far as that phase of the strike is concerned, we in Canada have nothing to do with it, it being a purely domestic affair for the United States authorities to deal with or not as they see fit. The whole strike, of course, is a purely domestic affair, but its effects are far from being domestic in their character.

A very large portion of the soft coal which our industries require is imported from the coal fields of the United States, and this is the time of year when in ordinary circumstances, large manufacturing firms try to obtain a sufficient reserve to guard against the delays and difficulties of transportation incidental to winter weather. Owing to the strike, instead of supplies being built up, they are being depleted. Little coal is being mined, and little is being exported, and the immediate prospects for improvement are poor.

It is doubly unfortunate, that just at a time when business in general is taking an upward trend, with every prospect of a continuance in that direction, that the menace of a coal shortage should be looming over us. We have passed through one hard winter, and there is every reason to hope that the employment situation will be considerably better this coming winter than last. It will be too bad if any of the betterment is lost through a shortage of coal.

This is a situation which once more calls to our attention the vast influence which the stationary engineer can exert, by making the most of the fuel that is supplied him. If the average efficiency of the plants in the Dominion was brought up to 60 per cent., instead of the 50 per cent. mark at which it stands at present, there would be an enormous saving in fuel and transportation, the money saved in that way being made available for the further development of industry. If the average efficiency could be brought up to what is now the highest mark achieved in the most up to date plants, which is 75 per cent.. the results would be commensurately greater. This latter figure as an average is one which it is too much to hope for in the immediate future, but there is no reason why the average efficiency could not be raised at least 10 per cent. This is a matter that lies strictly within the power of every man who has charge of a boiler, and it is up to him to do all he can to improve his own standard, thereby improving the general standard.

In the winter of 1917-18 and 1918-19 we saw strenuous, if largely misdirected. efforts on the part of the Government to introduce fuel efficiency in the Dominion, and many thousands of articles and sheets of instructions were printed, on the subject of conservation. Heatless days were instituted, on which factories were compelled to close down, in order to conserve fuel.

The hydro enthusiasts see the solution of the problem in obtaining power and heat exclusively from water power developments, without regard to costs or commercial practicability. In this way they say we can become independent of the U. S. coal supply. The further development of hydro power as carried on under public ownership is something that should be very carefully considered if the people in general are not to be penalised for the benefit of the few.

Until our population increases to a very great extent, so that freight rates can be brought down to a reasonable level, without getting our railways further in the hole, the fuel situation will be such that a large portion of Canada will have to look for its industrial fuel from the United States. The maritime provinces and Quebec can obtain coal from the mines in Nova Scotia by water carriage—the cheapest possible way. British Columbia has her own mines, so that the haul is not so great for her. It is Ontario and the middle western provinces that must depend on imported coal.

The more efficiently the plants are run, the less of this coal will have to be brought in. As we said before, the plant engineers are among the most important factors in the situation.

Who is Responsible?

THOSE WHO are in the habit of girding against what they term "the capitalistic system" would do well to consider some recent remarks of Lord Leverhulme and to ask themselves whether it is not themselves rather than the "system" which is at fault and responsible for the evils they deplore.

"Shall we take the growth and development of a capitalist," he says, "and see how he begins?

"I venture to say, if you will search back during the last two thousand years, you will come to this germ growth of a capitalist. It has been so in all ages; it is so to-day. We will take six young men entering any trade, engineers, or whatever it may be, at the same time, approximately the same age. One of them takes the view of what is outside the wage envelope—he is hard-working and saves. The other five, like the man with the one talent, have no sin; they are simply pleasure-loving, easy-going, and they never think very much about to-morrow. When their money comes it is spent, but they have no sin, no vice—they are merely pleasure-loving, easy-going.

"Now, the young man who saw more outside his wage envelope, saves and prepares a home and marries the girl of his choice. In process of time he is made a foreman; a little later on he is made a manager; a little later on he is an actual employer himself, and further, later on in life, the other five—who have committed no sin, remember—seeing him go past in his motor car, with a smiling wife and bonny children beside him, wonder how it is, and they come to the conclusion that it is the capitalistic system that has placed one man in the motor car and left the other five just where they were when they began. They adjourn to the nearest public house and pass resolutions against the capitalistic system, and determine it must be overthrown immediately, if not sooner."

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

HORSE POWER OF ENGINE

Question:—Will you please inform me through your question box how to find the horse power of an engine, double cylinder, 16 x 20 inches, 225 rev. per minute, cut off at 5-8ths stroke, steam pressure 100 lbs. gauge.

Answer:—The horse power of an engine is dependent on the size of piston, that is, the area, the length of stroke, and the number of revolutions per minute, and the mean effective pressure of the steam. This is stated in a formula as follows:

$$\frac{PLAN2}{33{,}000} = \text{H. P.}$$

In this P is the mean effective pressure per square inch, A is the area of piston in square inches, L is the length of stroke in feet, N is the number of revolutions per minute. The 2 is used to convert the revolutions per minute into strokes per minute there being 2 strokes to each revolution.

The divisor 33,000 is the number of foot lbs. in one horse power. A horse power is a rate of doing work, that is 33,000 foot lbs. in one minute. The power of an engine is measured in horse power as being a convenient unit, and the product of the force, which is the mean effective pressure multiplied by the area of the piston, into the distance through which it acts, that is the strokes per minute multiplied by the length of the stroke in feet, gives foot lbs., which when divided by 33,000, the number of foot lbs. in a horse power, gives the resulting horse power. The mean effective pressure is usually found from an indicator diagram, but when this is not available, and the cut off is known, it can be obtained approximately.

One method is by using the law which states that the pressure and volume of a gas vary inversely. That is, if one pound of a gas occupies a volume of one cubic foot, at a pressure of 25 lbs. per square inch absolute, and it is compressed to one half a cubic foot, the pressure will be doubled. On the other hand if the volume is increased to 2 cubic feet, the pressure is decreased to one half of its original pressure. This is expressed in a formula P V=C or pressure x Volume = Constant.

Now if the cut off in the engine is at 5-8ths stroke, and the gauge pressure is 100, then the absolute pressure is 114.7, or for a case like this we can use 115 lbs. The stroke is divided into eight parts, of which 5 are full of steam when the cut off takes place. That is P is 115 and V is 5 and the product of these is

$$115 \times 5 = 575$$

At the next point on the stroke 6/8ths, the product of pressure and volume must give 575, as P x V= C

$$P \times 6 = 575$$

$$P = \frac{575}{6}$$

At the next point 7/8ths stroke we have

$$P \times 7 = 575$$

$$P = \frac{575}{7} = 82.144$$

while at the terminal or full stroke the pressure will be

$$\frac{575}{8} = 71.875$$

We have now for the eight divisions of the stroke

Pressure	1st division	115
	2nd	115
	3rd	115
	4th	115
	5th	115
	6th	95.5
	7th	82.1
	8th	71.875
		824.475

We divide this by eight to get the mean pressure and this gives us

$$\frac{824.475}{8} = 103.059$$

This however is the absolute mean pressure, and in order to get the mean pressure above the atmosphere we must subtract 15 from the result which gives us 88 lbs. per square inch, mean effective pressure on the piston throughout the stroke.

This is not strictly accurate, as steam does not expand in a cylinder exactly in accordance with the law given here, but it is sufficiently accurate for all practical purposes. In order to get a closer result we should have to use logarithms.

This result again does not allow for any losses, such as the negative work due to cushioning, and a certain amount of loss due to the high terminal pressure keeping the back pressure line high during the first part of the exhaust stroke, the wire drawing of the slide valve ports in opening and closing to steam, etc., so that we can be pretty safe in deducting from the mean pressure as found by the formula 20 per cent. to make up for these losses. This would give a mean effective pressure about 70 lbs. per square inch. We can now put this value in the formula

$$\frac{PxLxAxNx2}{33{,}000} = \text{H.P.}$$

$$\frac{70x20x16x16x.7854x225x2}{12x33{,}000} = \text{H.P.}$$

$$= 315 \text{ H. P.}$$

As there are two cylinders this would give 630 as the total horse power. This seems a high value for an engine of that size, but in the absence of an indicator diagram, it is as close as we can get. The mean effective pressure is the factor that varies the most, and is dependent on cut off, back pressure, cushioning, etc. The revolutions are usually constant in a high speed automatic engine, and the stroke and piston area are always the same.

This leads to a method of easy calculation. Every engineer should have constants for the engine in his charge. For instance in this engine we have a constant speed, constant stroke, and constant piston area. If we multiply these together, and divide them by 33,000, we shall have a number that multiplied by the mean effective pressure at any time will give the horse power. The mean effective pressure of course will vary according to the load.

$$\text{Area x stroke x strokes per minute} = \text{Eng. con.}$$

$$\frac{16x16x.7854x20x450}{33{,}000} = \frac{16x16x.7854x20x450}{12x33{,}000}$$

$$= 4.57$$

Now if the mean effective pressure from the card should be 50 lbs. we have 4.57 x 50 228.5. If it is 60 we have 274.2. If 70 we have 319.9 and so on. If there are several engines in a plant, constants should be obtained for all of them. In some cases the speed may vary, in which case the constant would be the area x stroke, and divided by 33,000 leaving two variables, the pressure and speed.

HOW TO SPEND LESS FOR COAL

(Continued from page 20)

edge. Column B shows the saving to be $17.25. Even if the saving were only 5 per cent. the investment would pay, but inasmuch as 10 per cent. is guaranteed I have based this chart on that figure.

The Operators' Point of View

VOICE FROM THE WEST

Editor, The Power House,

Dear Sir,—

With reference to your editorial and Mr. Wright's letter in the issue of May 20th on "A Move for the Universal Certificate," I have a few observations to make that may be of interest to engineers concerned.

Mr. Wright is to be commended for the practical interest he is taking in the matter, but there are some of us out west here that consider the logical method is not being adopted. In the first place, Mr. Editor, without considering at all the difference in the exams that may or may not exist between the eastern and the western provinces, there is the all-important point of the service qualifications for these exams.

I would suggest that the eastern engineers give Mr. Wright their support towards getting their Provincial Regulations amended regarding the qualifications required for the different grades. Having secured these on somewhat of a par with the western provinces, there would then be common ground upon which to approach the Federal Govt. for the uniform certificate. So long as you have Regulations in the east that permit a man in one province to take a first class exam. with a total steam plant service of one year as fireman, and in another province only one year firing and one year as engineer of a 200 h.p. plant, no system of Identification Cards, permits or anything else will guarantee that man a uniform standing or grading in the west as an engineer.

If a convention of the Chief Boiler Inspectors of the different provinces could meet upon the common ground of equal qualifications and exams for the engineers and their respective provinces it would then be a simple matter for them to draw up and recommend to their governments regulations for the exchange of Provincial certificates upon payment of a small fee to cover registration. The Provincial Boiler Inspectors and Examiners are the logical men to bring this questioin before their respective legislative bodies, because they, more than anybody else, understand the problems connected therewith, and are in touch with both the engineers and governments.

The exchange of Provincial certificates as above, or the Card System advocated by Mr. Wright will never function while the present disparity in the Provincial Regulations exists. While Mr. Wright's card system might work out successfully in the east, let me illustrate its descrepancy when applied to the west. Suppose an engineer to be leaving, say Quebec, to find work in B. C. He would apply for his identification card to the Que. examiner, who would also send a duplicate one to the B. C. examiner which would vouch that the man named was, say a first-class engineer, in Que. To quote Mr. Wright, "when he reaches B. C. he notifies the examiner and produces his card, which upon being compared with the copy in the B. C. examiner's possession, and being found correct, entitles the holder to a permit of the same grade for as long as he wishes to remain in the province."

This engineer having a first in Que. has had to show service of one year as fireman and three years as mechanic to qualify for the exam. there, if my information is correct. But in B. C. this service would only entitle him to try the fourth-class exam. instead of the first and yet under the card system he would expect to be registered as a first-class engineer working under a permit. Before being eligible for the first-class exam. the present regulations would require this engineer to put in the following additional service of three and one-half years:—6 months as engineer of at least a 10 h.p. steam plant, requiring a fourth certificate; 1 year as engineer to have secured his certificate plant, requiring a third; a further year as engineer of at least a 300 h.p. steam plant, requiring a second; and still another year as mechanic. Does Mr. Wright consider this too much steam plant experience to require of a first-class engineer?

On the other hand, suppose an Ont. first-class engineer moved to Alta. and applied for a permit under the card system. So far as the regulations in his home province go, it would be quite possible and not at all improbable for this engineer to have secured his certificate after the following service:—3 years as apprentice blacksmith, 1 year as fireman, 1 year as oiler, 1 year as engineer of a 200 h.p. steam plant, and Ye Gods: 6 years as engineer(?) of a 200 h.p. motor-driven air-compressor plant. Out of 12 years of his experience he could show a total steam plant service of 1 year as fireman, and 1 year as engineer of a 200 h.p. plant. This service being possible in your province, Mr. Editor, can you say it is sufficient to fit a man to take charge of a modern steam plant anywhere in Canada?

The above engineer (?) by means of his identification card would be entitled to trade his experience for registration in Alta. as a first-class engineer, where the local man has to show service under the present regulations of 2 years as machinist or boilermaker, and double the steam plant time required of the Ont. man, and with plants of greater horsepower. Of course the Alta. engineer has not the advantage of the blacksmith apprenticeship.

Considering the above disparity in service required by the present regulations in the east and west, is this not the first kink to be straightened out in the initial steps towards the uniform certificate? If my understanding of Mr. Wright's card system is correct, then if adopted, it would certainly pay the prospective western engineer to go east for his examination (first-class of course), then return and hand in his card for a first-class permit in Alta. and B. C. He would be years ahead.

The point made by both Mr. Wright and yourself, Mr. Editor, that retaining the revenue of the engineers' certificates in the provinces instead of it going to Ottawa "would please the politicians," is a touch of the cultured east that does not appeal to us out here. We are not out to please the politicians. The administration of the Boiler and Engineers' Regulations is kept out of politics in the west, and is in the hands of practical and competent men for the purpose of public safety, not for revenue as a primary consideration. We do not have to renew our certificates yearly here, like getting the car license. When a man pays the examination fee and gets his certificate, why on earth should he be taxed yearly for having proved that he is a competent man to handle steam plants without menace to the public? If your system is right, Mr. Editor, why not expect McGill to attach an annual renewal fee to their diplomas?

There is no desire on the part of the writer to criticize the engineers in the east who have served a real apprenticeship to the craft, studied and earned their certificates; but it can hardly be denied that the regulations there at present require to be tightened up considerably for the good of engineering in general, and before the word "uniform" can be properly applied to the desired Dominion certificate.

The suggestion re the Provincial Boiler Inspectors meeting in convention for the purpose of drawing up re-

gulations for interchange of certificates is made in view of their success with the Uniform Boiler Regulations, and principally because they would know exactly what they were talking about.

Yours truly
J. A. Carruthers.
Lethbridge, Alta.

Editor's Note

We would like to point out to Mr. Carruthers that the very basis of the Inter-Provincial or Dominion Wide certificate is that there shall be both uniform qualifications as well as uniform examinations.

As regards the question of "pleasing the politicians," which Mr. Carruthers mentions, neither Mr. Wright nor the Editor of Power House, suggested that politicans be taken into account in the matter. What was said, had reference to administration and not to politics. Each Government department in every province is dependent on its revenues for operation, and from the point of view of the heads of those departments, giving up a source of revenue is a thing to be avoided. As a general rule the actual administrative head of a department is not a politician in the sense that Mr. Carruthers would infer.

We must respectfully decline to accept the insinuation that the system of renewal licenses is ours in any shape or form. If Mr. Carruthers would read over this correspondence from its inception, he would discover that we are not at all in favor of the annual renewal fee.

We, personally, do not wish to see any distinction between the East and West. The thing to strive for is the thing that will be best for all Canadians, and the Dominion of Canada as a whole. Mr. Carruthers' suggestion for the Chief Boiler Inspectors, or the Chiefs of the Examining Boards as the case may be, to get together and formulate an uniform law, is quite in line with what the writer and I think also Mr. Wright had in mind.

It is very good of Mr. Carruthers to allude to us as the cultured east, and in order to justify his good opinion, we refrain from the obvious retort.

C. A. S. E. EDUCATIONAL PROGRAMME

Eighteen meetings will be held between September, 1922, and May, 1923, under the auspices of the educational committee, Canadian Association Stationary Engineers. Two sessions will be held each month. The list of subjects follow:

(1922) C. A. S. E. (1923)
Educational — Program — Subjects, etc.

1. Sept.—Fuels; wood, coal, oil, refuse.
2. Sept.—Discussion, questions and answers.
1. Oct.—Boilers, furnaces and settings.
2. Oct.—Discussion, questions and answers.
1. Nov.—Combustion, temp. and draft.
2. Nov.—Discussion, questions and answers.
1. Dec.—Grate-bars, shaking and stokers.
2. Dec.—Discussion, questions and answers.
1. Jan.—Appliances, necessary, in a B-R.
2. Jan.—F. W. and Circ. pumps, types and makes.
1. Feb.—Miscellaneous auxiliaries desirable.
2. Feb.—Steam engines, types and makes.
1. Mar.—Meters, indicating and recording.
2. Mar.—Instruments, indicating and recordig.
1. Apr.—Boiler room efficiencies.
2. Apr.—Engine room efficiencies.
1. May.—Report forms and records; also surveys.
2. May.—Useful formula and data, for engineers.

Branch Educational Committee to be appointed by president of the local branch and same is to consist of chairman, who may be an Associate M.; secretary, preferably the conductor, inquisitor or Instructor.

Regulations and suggestions for the program:—

1st. That all papers should be presented by some member of the local branch or association.

2nd. That the questions should originate from members of the branch or association; except such as may be suggested by the general committee.

3rd. That answer may be given by others than members of the branch by permission or request of the chairman of the Educational Committee.

4th. The recording secretary or the conductor is to make brief verbatim reports of the questions and answers.

5th. Credits will be given for the number of questions asked as well as the number of correct answers made; however duplication should be avoided.

6th. Any member having a problem at his plant if marked "urgent" must have priority over the regular program, as he may have to leave before meeting has been concluded.

7th. All questions not marked urgent are to be deferred by the inquisitor until the subject to which they particularly appertain is under consideration, when full credit will be given.

8th. Members should, as far as possible, try to anticipate the questions, or information they desire to have brought out by the discussion, and hand same in writing to the chairman of the Educational Committee (in advance when possible) marking the subject and date for discussion.

9th. Magazines, text books, hand books, etc., may be consulted prior to the meeting for purposes of preparing paper or answering questions; but should not be used during, or subsequent to the meeting, for the purpose of answering questions asked during the previous meeting.

10th. The chairman, secretary and inquisitor, or instructor, should all three sign the written report of the paper read and the record of the discussion consisting of questions and answers; stating specifically "brief verbatim report."

Note.—If prizes are offered to the general educational committee to be awarded to the branch showing highest proficiency, the nature of same will not be disclosed by the committee until contest has been closed.

Geo. J. Soucy, chairman of general Educational Committee, T. H. Fenner, C. E. Hansen.

TORONTO NO. 1 C. A. S. E.

C. A. S. E. Toronto No. 1 are enjoying very prosperous times as is evident by the fact that at the recent C. A. S. E. convention held in Kitchener, Toronto No. 1 were the first prize winners for having the largest increase of new members of all the branches of the C. A. S. E. for 1921-22.

Also in the matters of education the older members helped the new ones to carry off the first prize in the Engineers, educational contest, the list of questions being supplied by a committee selected by The Dominion Flowmeter Co., the judges of the contest being T. H. Fenner, Editor of The Power House, J. Thompson of The Dearborn Chemical Co. and Gordon Keith of "Canadian Manufacturer." This contest was keenly contended by all the Branches of the C. A. S. E. Toronto No. 1 has a very excellent Engineers' Library, two steam engine indicators, a Flowmeter and several engineering instruments and appliances for the use of the members.

The Toronto Executive extends a hearty welcome to all engineers who wish to become members and to all members to help boost the membership of the next convention will be held in Toronto, 1923.

A PERFECT HAND DRILL

The ordinary small hand-operated drill is widely used on account of its convenience, but it has the drawback that it is not quite so accurate in its work as a proper machine drill. With the object of getting over this disability a British firm of tool makers has designed a new type of hand drill which does as good work as the high grade machine drill, while retaining all the simplicity of the hand-drill. Both a high and a low speed are provided; and another very useful feature is the automatic action by which the drill is fed forward as it proceeds through the work. The work table of this little machine can be swung to any angle and also rotated round a vertical column, so that the drilling of holes at any angle is a comparatively easy matter. The machine is designed for hard work and can drill holes up to one inch in diameter. The height of the machine is only forty inches and it is made throughout with exactly the same minute care as is expended on the best British machine tools.

Practical Electricity for the Power Plant Engineer

By G. R. ARCHDEACON, A.M.I.E.E.

THE PASTED plate is much cheaper to manufacture, but has a shorter life than the Plante plate. As the Pasted plate is more in demand we will only consider that type in detail.

In making the Positive plate, certain quantities of Red Lead are mixed with dilute Sulphuric Acid to form a fairly stiff paste. This paste is then rubbed into the skeleton leaden framework, untill this framework is entirely filled with the Red Lead.

About 5 other chemicals are used in combination with the Red Lead with the object of making the paste or active material, more porous, give greater adhesion to the grid. These processes are all closely guarded trade secrets. However fully 90 per cent of the Negative active material is Litharge.

After these plates have been pasted they are kept in a certain temperature for about 10 days whilst they are perfectly dried. They are then taken and placed in large tanks and are "pickled" or formed for about 5 days and then they are ready to be assembled into a cell.

When they are assembled and inserted into the jars dilute sulphuric acid is poured in until the tops of the plates are just covered with this fluid.

This fluid is called the electrolyte. The electrolyte must be made from sulphur. It is most important the electrolyte should be kept chemically pure, therefore acid made from pyrites should never be used, as it is likely to contain injurious substances.

Acid of "full strength" must never be used or the cell will be ruined. The strength must be reduced by the addition of distilled water. Never use water that has not been distilled.

In mixing the acid and the water, never pour the water into the acid. Always pour the acid into the water, or serious accidents may result.

The density of the acid must be reduced from its "full strength" of 1.843 down to 1.220 or 1.280 depending upon the service to which the storage battery is intended.

This is usually determined by the aid of a hydrometer. Water being considered as our standard of density is considered at 1.000. Therefore the weight of our electrolyte is in the ratio of 1280 is to 1.000.

Between the plates are inserted the wooden separators. These separators have to be carefully chosen, and then need to be neutralized by boiling in strong caustic soda, until all the wood acids, or resins are neutralized, and the fibre of the wood rendered porous to permit the free circulation of the electrolyte through the wood.

There are always an uneven number of plates in a cell, and they are so arranged that there is one more negative plate than positive. This is because it is necessary to have a plate surface of opposite polarity facing a plate for it to become active. Therefore the two end plates which face the walls of the jar cannot have that side of the plate active. Therefore that surface is wasted. Fig. 1.

The negative is somewhat cheaper to manufacture than the positive therefore a negative is always used for the end plates, and frequently these end negatives are made much thinnner than the plates used in the interior of the cell.

The glass jars are covered with thin sheets of glass to prevent the electrolyte "spraying over" when no charge.

The glass containing jar should be mounted on double glass insulators. These insulators being immersed in oil, the object being to prevent "creeping" and consequent loss of charge due to the leakage.

We now have the following chemical combinations to consider:

Positive plate. Lead peroxide or Pb O^2.

Negative plate. Litharge or lead monoxide Pb O.

Electrolyte. Sulphuric acid. $H_2 SO_4$.

When the charging current is sent into this combination the process of electrolysis takes place, the hydrogen ions and the oxygen make their passage through the electrolyte acting and reacting upon each other, decomposing the electrolyte, and the chemicals in the plates of the battery.

How The Storage Battery "Works"

In the last chapter it was shown what materials entered into the operation of the storage battery. They are sulphuric acid, water, pure lead, lead sulphate, and lead peroxide.

It is important to notice that all these substances are chemical compounds, with the exception of the pure lead, which is an element.

Sulphuric acid chemical formula H_2SO_4.

This is a chemical compound consisting of 2 parts of hydrogen 1 part of sulphur, and 4 parts of oxygen.

Water—Chemical formula H_2O.

Pure lead—Chemical formula Pb. this is an element and not a compound.

Sulphur—Chemical formula S, this is a solid and an element.

Hydrogen—Chemical formula H, this is a gas.

Oxygen—Chemical formula O, this is a gas.

Lead sulphate—Chemical formula Pb SO_4. This is a solid and is due to the chemical action which takes place immediately lead comes into contact with sulphuric acid.

Lead peroxide—Chemical formula Pb O_2. This is a solid and consists of 1 part lead and 2 parts of oxygen.

It will now be recalled that according to the laws of electroylsis, that when a current of D. C. electricity is passed through any conducting solution, that solution is split up into its original elements.

When the storage battery is connected to a source of D. C. electricity, and a current passed through the solution called the "electrolyte," chemical changes immediately take place, the compounds above enumerated are split up into the substances from which they are made.

We then have lead, or Pb, Hydrogen or H, Oxygen or O, and Sulphur or S.

The sulphur does not completely separate itself and form its original element in a solid form, but its combina-

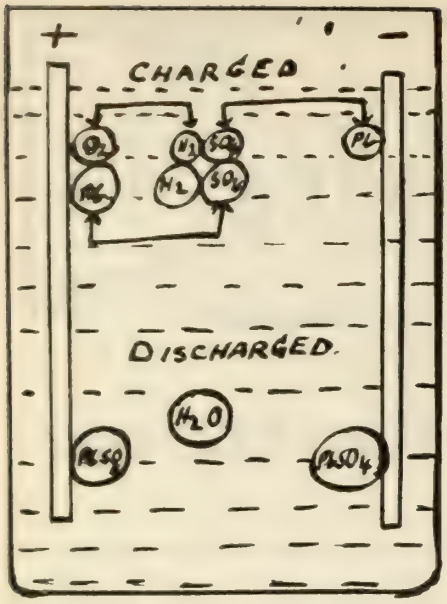


FIG. I

tion with the hydrogen to form sulphuric acid, is split up into H_2 and into SO_4. Whilst its combination with the lead or Pb to form lead sulphate or Pb. SO_4 is split up into Pb and SO_4 respectively.

In other words the sulphur always remains combined with four parts of oxygen.

Let us now consider a simple storage cell having 2 plates only, 1 negative, and 1 positive.

Immediately we pour into this cell the electrolyte, which is a diluted sulphuric acid, the acid immediately atatcks the lead plates, and also the paste or active material on the plates, and begins to turn them into lead sulphate, or what is popularly termed "sulphates" them. If this condition is permitted to prevail for any prolonged period of time, the plates will be ruined. We must arrange to "charge" the cell as quickly as possible after the acid has once been poured into the cell. Let us therefore first consider the fully-charged cell.

When the cell is fully charged, it is in a condition to supply current for a definite period of time.

The positive plate consists of lead peroxide (Pb. O_2).

The negative plate consists of lead (Pb) but in a very finely divided condition, and known as sponge lead.

The electrolyte consists of sulphuric acid. (H_2SO_4) Fig. 1.

When the positive and negative of the cell are connected to some current consuming device, and the switch closed the cell begins to discharge, and the following changes take place:

Positive plate:

Lead peroxide (PbO_2) and sulphuric Acid (H_2SO_4) and two parts of hydrogen (H_2) produces two parts of water ($2H_2O$) and one part of lead sulphate ($PbSO_4$).

This is usually expressed as follows: $Pb\,O_2 + H_2SO + H_2 = PbSO_4 = 2H_2O$.

At the Negative Plate, however, an entirely different set of conditions prevails.

Remembering that the Negative plate is in a fine state of Sponge Lead, the Sulphuric Acid naturally has greater access to the molecules of Lead, and consequently can react upon them to a much greater degree.

These changes are therefore as follows:

Lead (Sponge) or Pb and Sulphate (SO) produce Lead Sulphate. PbSO.

This is usually expressed as follows:

$$Pb + SO^4 = PbSO_4$$

In other words the Chemical changes during DISCHARGE produce Water and Lead Sulphate at the Positive Plate.

Whilst at the Negative Plate only Lead Sulphate is formed.

Chemical Changes on Charging

When we connect the Positive and Negative Plate to a D. C. Dynamo and send Current through the cell a complete reversal of the above changes take place.

The Lead Sulphate which has formed on the Positive Plate is gradually changed back to Lead Peroxide, and the Sulphuric Acid that had impregnated the plate will return into the Electrolyte.

The Lead Sulphate on the Negative Plate is returned to the Electrolyte leaving the plate again pure Lead, only in a Sponge condition.

From this brief explanation it will be apparant that we are not STORING Electricity, the sell is not a STORAGE BATTERY in the popularly accepted understanding of the term.

All the above changes in the Chemical structure of the "working parts" is precisely in full accord with the underlying principals of Electrolysis as laid down by Michael Faraday.

These Chemical actions and reactions are not instantaneous, the action is a gradual one, and is controlled by the rate of Current Flow, and also upon the Length of Time during which the Current is permitted to flow.

This applies equally to the Charging as well as the Discharging.

The higher the number of Amperes used, or the longer the time in which the Amperes flow through the cell, the greater the amount of chemical action will result.

It will be obvious that sooner or later all the Lead Sulphate will have been used up, or REDUCED as it is technically termed, and no more Sulphur will be sent into the solution.

When such a condition obtains the cell is said to be fuely charged.

If we continue to send the charging current through the cell when it has reached the state of being Fully Charged the Water in the Sulphuric Acid will be decomposed into its natural elements, HYDROGEN and OXYGEN. These will rise to the surface of the Electrolyte in form of "bubbles" the cell is then said to be gassing freely, this being one of the principal indications of a cell being in a Fully Charged Condition.

Recently thre has appeared numerous "quacks" who claim to be in possession of so called Non-Sulphating Storage Battery, yet still use Lead and Sulphuric Acid as active elements in their "wonderful" invention.

Such a claim is so absurd that serious chemists do not take the trouble to give the matter the publicity it deserves.

In any lead-acid storage battery, it is a chemical impossibility to obtain electricity unless there is sulphation of the elements.

To claim that a Lead Acid Battery can work without Sulphation, is just as absurd as claiming that COAL CAN BURN WITHOUT Oxygen.

Voltage of Cell

When continued CHARGING has finally resulted in the presentation of the usual indications of a fully charg-

(Continued on page 34)

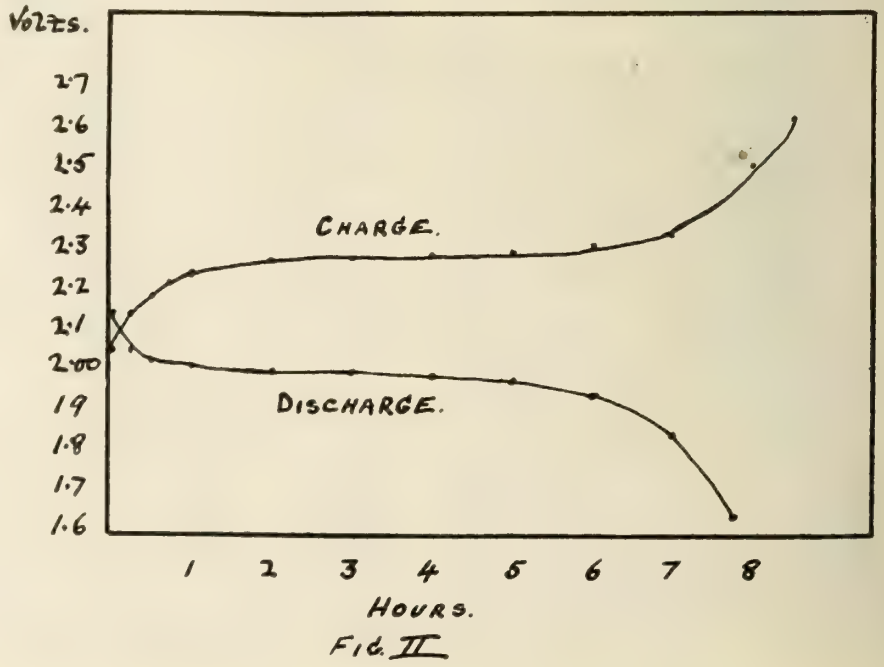
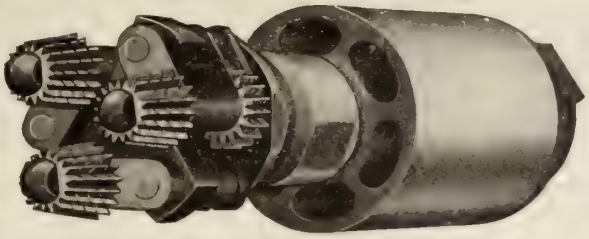
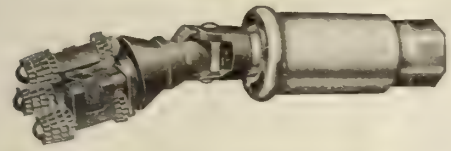


FIG. II

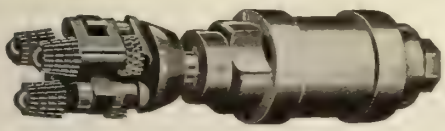


Standard Water Driven Tube Cleaner

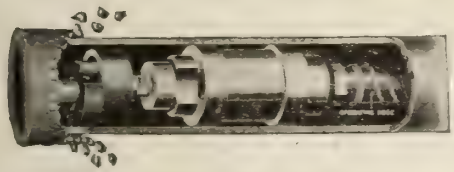
KEEP YOUR BOILERS CLEAN



Lagonda Water Driven Cleaner for Curved Tubes



Lagonda Air Driven Cleaner for Straight Water Tubes



Cleaner Removing Scale from Outside of Fire Tube

All natural waters contain some impurities which, when introduced into a boiler, may appear as solids deposited on the heating surface. No matter what the substance consists of, it must be removed at frequent intervals or it will decrease the capacity and efficiency of the boiler and may cause it to be badly damaged by over-heating.

Some waters, notably well waters, deposit such quantities of scale that they should be purified before going into the boiler, thereby preventing an accumulation of incrustation and consequent damage to boiler parts, and at the same time effecting a large saving in fuel by keeping all parts of the heating surface in a clean and efficient condition. If you have bad feed water it is a case for the chemist, for the scale is probably composed of several substances which must be known before the exact treatments necessary to get rid of them can be determined upon. The use of treatment without technical advice is poor policy.

Stony and vegetable matter in suspension can be removed by FILTERS, which we supply in various sizes and designs to suit all requirements. In most Canadian plants, lake or river water is used for feed, and these waters seldom carry large quantities of scale-forming materials in solution. Scale can be allowed to form in the boiler for a considerable period. Experience in each individual plant determines the limit at which tube difficulties will begin or a perceptible falling off in efficiency will take place. With such a limit of scale formation fixed, and the danger of allowing it to be exceeded, well understood, probably the most economical and efficient method of keeping the heating surfaces clean is by use of the LAGONDA TUBE CLEANERS.

The cleaners are designed and so constructed as to thoroughly remove all the scale, in the shortest possible time, at the lowest cost of operation, and they require a minimum amount of repairs, reducing both the waste boiler time and labor cost of cleaning.

They are made to operate by either water, air or steam, and electricity. In every case a swing head is furnished so designed that three sets of cutters are thrown out by centrifugal force against the scale in such a manner that they make straight line contact with the tube and they do the work without damage to it.

You can be supplied with LAGONDA tools for cleaning Economizers, Condensers, Evaporators and other tubular plant.

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PRACTICAL ELECTRICITY

(Continued from page 32)

ed Cell, we will find if we place the wires of a low reading VOLTMETER across the Terminals of the Cell, that is a Voltage Reading of 2.60 to 2.70 Volts.

If we now stop the Charging Current and again apply the Voltmeter we will only obtain a reading of about 2.15 Volts.

The reason for this being due to the formation of lead sulphate in a very thin layer all over the surface of both plates.

This Voltage is of little value to us as an indication of the condition of the Cell, this is called the OPEN CIRCUIT VOLTAGE.

To obtain a truer indication it is necessary to obtain a reading when the cell is doing work. We therefore take regular readings of Voltage when the cell is Discharging at the average normal rate of Discharge for which it is designed. If the Cell is fully Charged it will show a reading of 2.00 to 2.15 Volts.

When current is being drawn from the Cell whilst DISCHARGING, the Voltage of the Cell immediately begins to fall, and falls at a very rapid rate at the beginning of the Discharge, and then follows a "straight line" for several hours, after which it again falls rapidly down to Zero.

This Characteristic is shown in Curve of a cell discharged in 8 hours (Fig. 11).

The reason for this fall of Voltage is due to the formation of Lead Sulphate ($Pb\,SO^4$) on the surface and also within the "pores" of the active material. As the sulphate forms in the body of the plates, the Acid is used up. This results in a general weakening of the Strength of the Acid, consequently the Chemical Action between the Acid and the Lead Peroxide is naturally reduced.

Furthermore, the Lead Sulphate is of considerable higher Resistance than the Lead Peroxide, and as a result, as the Active Material becomes more and more "Sulphated" this Resistance increases, resulting in an increase of the Internal Resistance, which in turn causes the Voltage to fall.

As this Sulphation is continued a complete cover of Lead Sulphate gradually forms over the surface of the plate, preventing the accession of a further supply of acid reaching the interior layers of active material.

Theoretically, it is possible to Discharge a cell down to Zero Voltage, but in practice it is never permitted to Discharge a cell after the Voltage has fallen to 1.65 Volts.

If the discharge is continued beyond this point both the positive and negative plates will have become so impregnated with lead sulphate that they cannot further respond to the action of the acid remaining in the tank, because of its strength having been reduced to almost the density of water.

Furthermore the plates which have become sulphated to such an extent need very careful handling on re-charging the cell, because lead sulphate is a

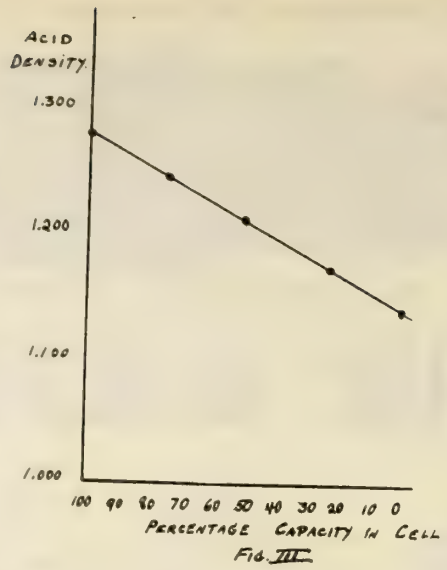

Fig. III.

non-conductor of electricity, as a result the internal resistance of the cell is increased. If we recall the earlier lessons, we will remember that if we increase the resistance of a circuit we increase the amount of heat generated by the passage of a current round that circuit.

Specific Gravity of Electrolyte

The electrolyte must be of sulphuric acid made from sulphur. Acid made from pyrites should never be used as it contains injurious substances.

The density or specific gravity is a varying quantity varying for the design of cell, and for the degree or discharge of any particular cell. (Fig. III).

Sulphuric acid of "full strength" has a specific gravity of 1.835. This is much too "strong" and cannot be used in a cell until it is diluted with distilled water down to the correct Sp. G.

The specific gravity usually employed is 1.200 and 1.225 for storage batteries for use power houses, telephones, fire alarms, etc., whilst for automobile self starters, or electrically propelled vehicles, specific gravities ranging from 1.280 to 1.300 is the standard practice.

It will now be apparent why the specific gravity will vary according to the state of charge.

It has already been shown that as the cell discharges the plates become sulphated. Now where does the sulphur come from? From the sulphuric acid. The sulphuric acid being merely a mixture of sulphur and water. Therefore if we abstract some of the sulphur the percentage of water remaining in the electrolyte will be increased and as the specific gravity of water is 1.000, the more sulphur abstracted from the solution the nearer will the density of the solution approach that of water.

Therefore whilst the battery is being discharged the SO_4 is abstracted from the electrolyte, and when it is being charged the sulphur is driven back into the electrolyte.

From a study of this fact it will be obvious that the actual state of the specific gravity is an indication of the state of charge or discharge of the cell.

In addition to the specific gravity it is necessary that the correct volume of sulphuric should be provided, as the more electrolyte present in the cell the better will be the performance. This quantity is unfortunately varied over a wide range, and what is lacking is volume is made up by increasing the density of such electrolyte present.

Self starter batteries electrolyte density 1,280 volume 4 lbs. of electrolyte per 100 ampere-hours capacity.

Power house batteries electrolyte density 1.215 volume 15 lbs. of electrolyte per 100 ampere-hours capacity.

Capacity of a Cell

The capacity of a storage battery is the amount of electrical energy we can get out of it. This is measured in ampere-hours.

Theoretically, a battery has a capacity of 100 ampere-hours if it is capable of delivering 10 amperes steadily for 10 hours, and then be unable to deliver more current.

Based upon this theory the cell capacity would be the number of amperes it is capable of delivering steadily for the number of hours it is capable of so doing, and at the end of that period to be incapable of delivering more current.

In practice however this is not so, because we never discharge a cell down to zero. A limit on the final voltage has to be fixed, this is called the final terminal voltage, and again is a varying quantity, varying with the rate of discharge.

This is limited by the following formula:

$E = 1.66 + 0.0175 \times T.$

When E final voltage. T time in hours of proposed discharge.

The capacity of a cell depends upon the following factors:—

(1) Area of plate surface.
(2) Quantity and porosity of active material.
(3) Quantity of electrolyte.
(4) Density of electrolyte.
(5) Circulation of electrolyte.
(6) Temperature.
(7) Rate of discharge.

In a well designed cell made by the large manufacturers factors from 1 to 5 are all in accordance with well established scientific practice.

The rate of discharge is one of the most important limiting factors of the capacity.

It has therefore become necessary to establish some standard time for the rate of discharge. This is considered to be the 8-hour rate. If the rate of discharge is increased the ampere-hour capacity is diminished. If the rate of discharge is reduced the capacity is increased.

Generally speaking the capacity of a well designed cell when discharged in 8 hours is just twice the capacity of the same cell when discharged in 1 hour.

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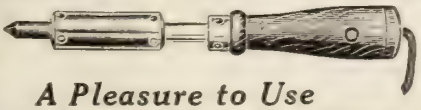

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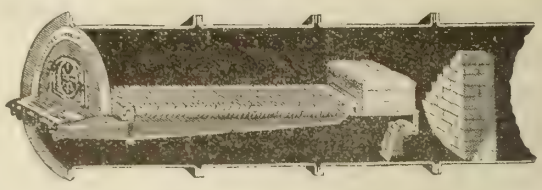

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New Truths and Old Fallacies

A PARTING SHOT

Now, in conclusion, please excuse us for paying our respects to certain competitors whose shibboleth is "just as good," or "the same thing" as Magnolia.

Admit, if you please, for the sake of argument, that they know, at least, the approximate formula of Magnolia—then what? Does an analysis show our foundry practice and thermal treatment? Does it show our graphite treatment? Have most of these people ever heard of impurities of low atomic volume, or have they the remotest idea as to what an eutectic is, as applied to babbitts?

Their literature, that we have seen, denotes their entire ignorance of these subjects, and never, by any chance, give comparative figures of tests, with and without lubrication, or have anything to say regarding co-efficients of friction. Apparently the extent of their information is confined to a knowledge of the formulas of the general run of "commercial babbitts," and the finer points of compounding are evidently not dreamt of in their philosophy.

Some of them will make any claim and quote any price to obtain business, without regard to the interest of their customers, and this is often done by well-meaning people who are uninformed on the subject.

No other concern than Magnolia Metal Company has ever given out so much useful information regarding babbitt metals. When it comes to the cold analysis of figures and facts, is not the discreet silence of other concerns a fair inference that they have nothing of equal value to report?

We lay our cards on the table face up, and ask that our competitors be at least required to do the same thing.

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(Continued next month)

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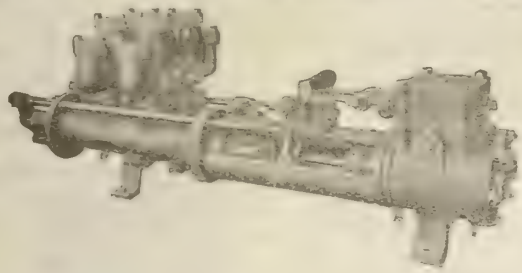

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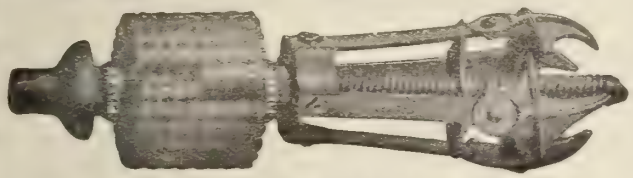

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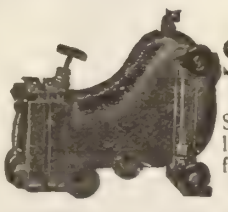

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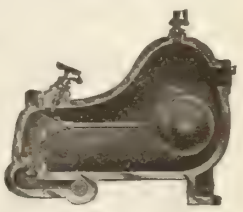

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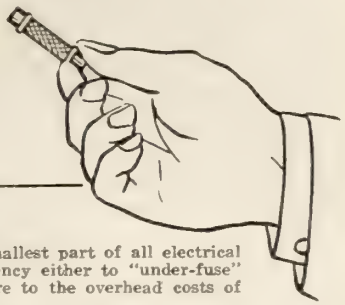

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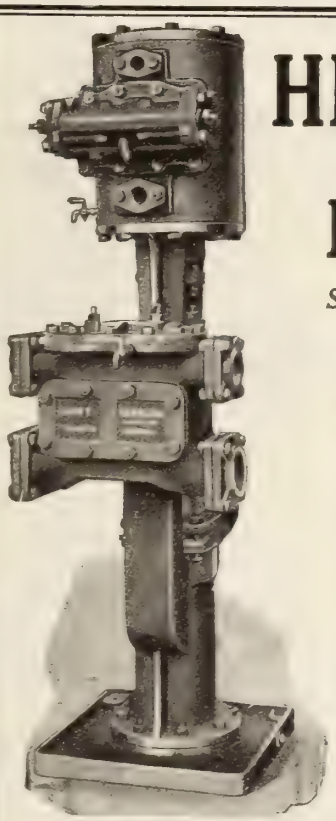

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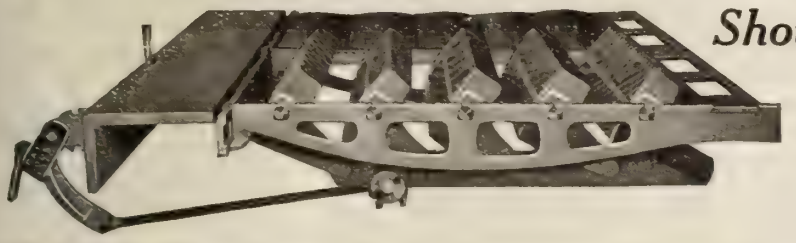

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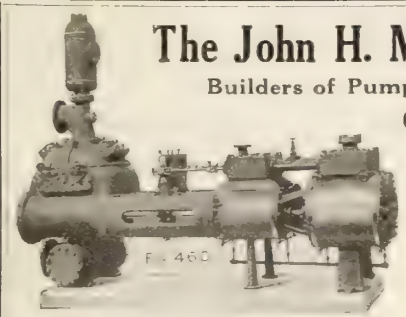

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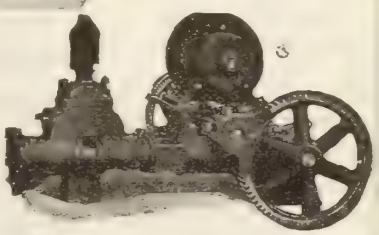

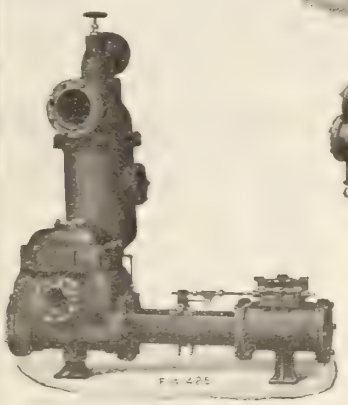

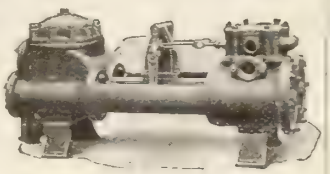

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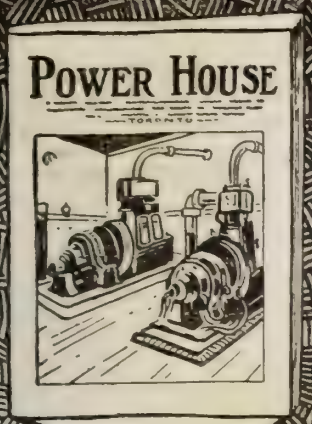

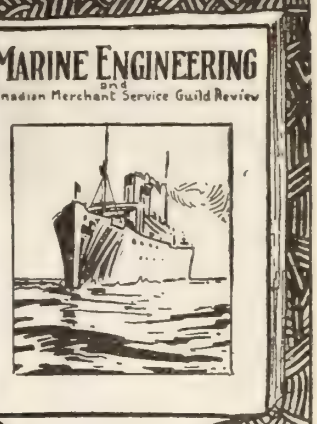

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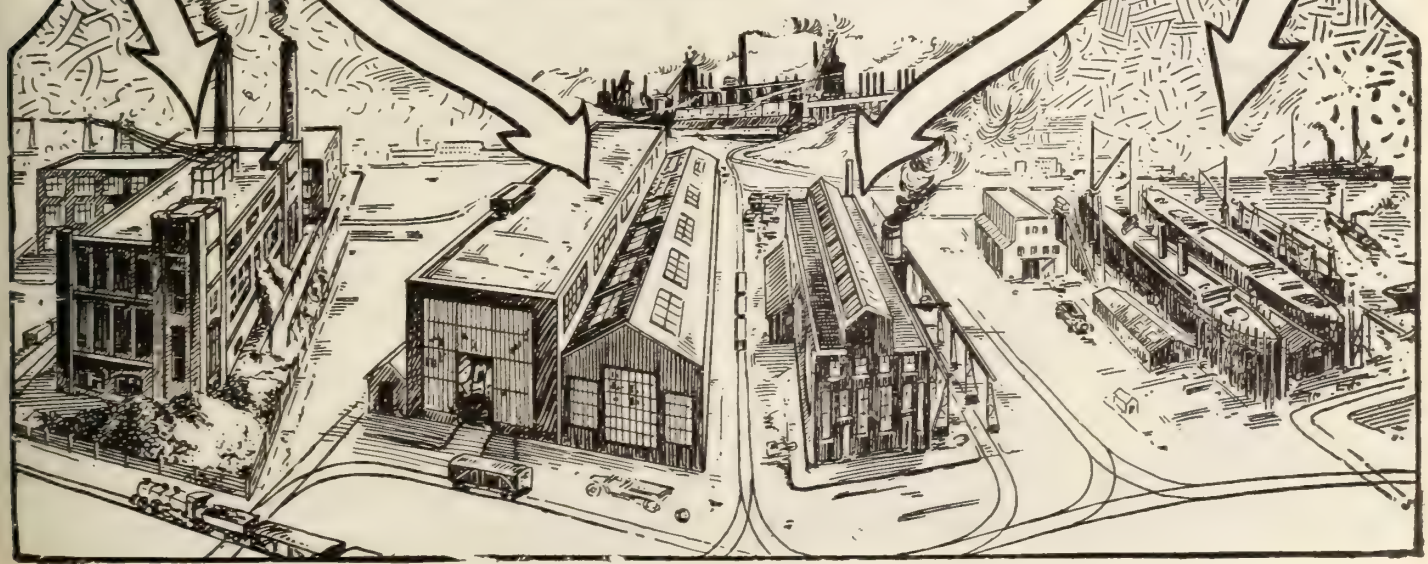

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R. C. Miller Oil & Supply Co., Ltd.,
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Flexible Metallic Packing Co., Windsor, Ont.
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Flexible Metallic Packing Co., Windsor, Ont.

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Goldie & McCulloch Co., Galt.
MacGovern & Co., Inc., Montreal
MacGovern & Co., New York
Waterous Engine Works Co., Brantford.

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PRESSURE AND REDUCING VALVES
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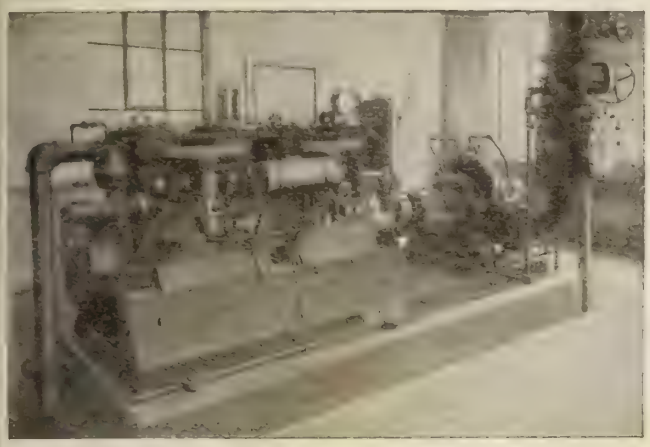

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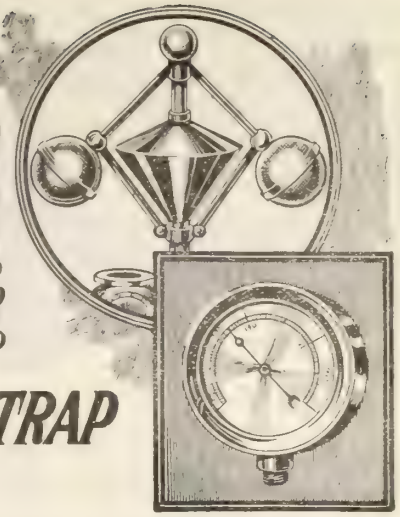

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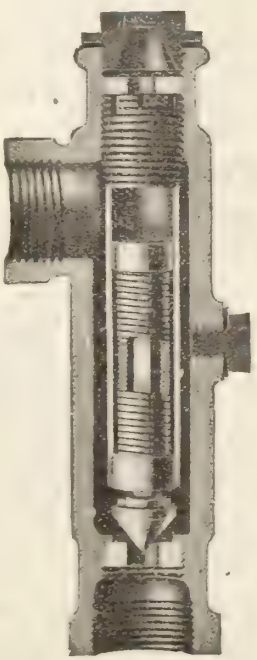

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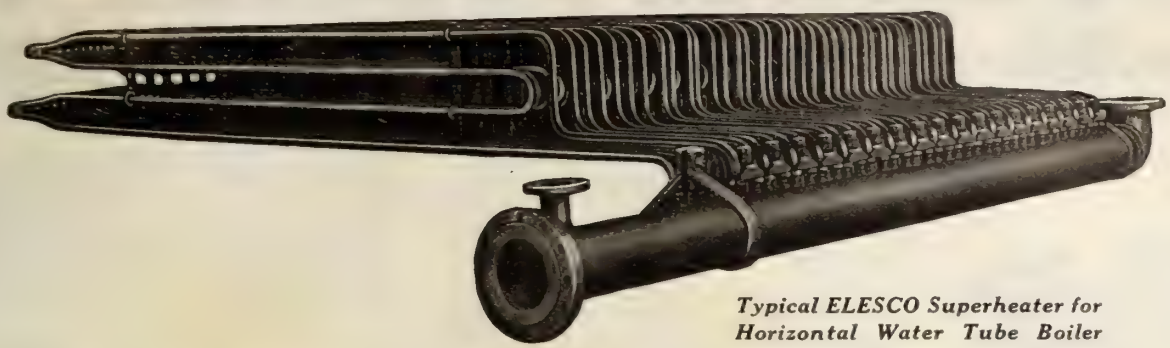

Typical ELESCO Superheater for Horizontal Water Tube Boiler

Maximum superheating efficiency and capacity, ease of application, accessibility, and long life, essential points in superheater design, are found in the ELESCO Superheater.

FOR EXAMPLE.

Headers are usually located outside of the hot gas path, and in many cases outside of the boiler setting, where they are accessible. The inlet to the saturated header and the outlet from the superheated header are at opposite ends, assuring an even distribution of steam flow through all units.

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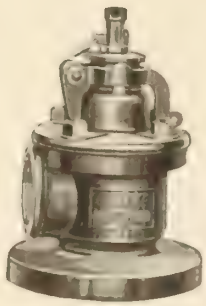

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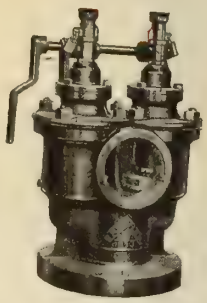

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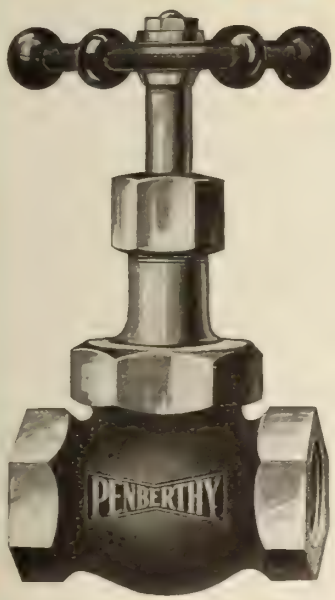
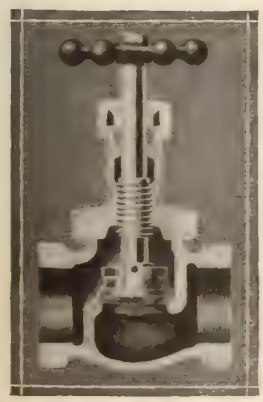


Exterior View
Regrinding Globe Valve



Sectional View
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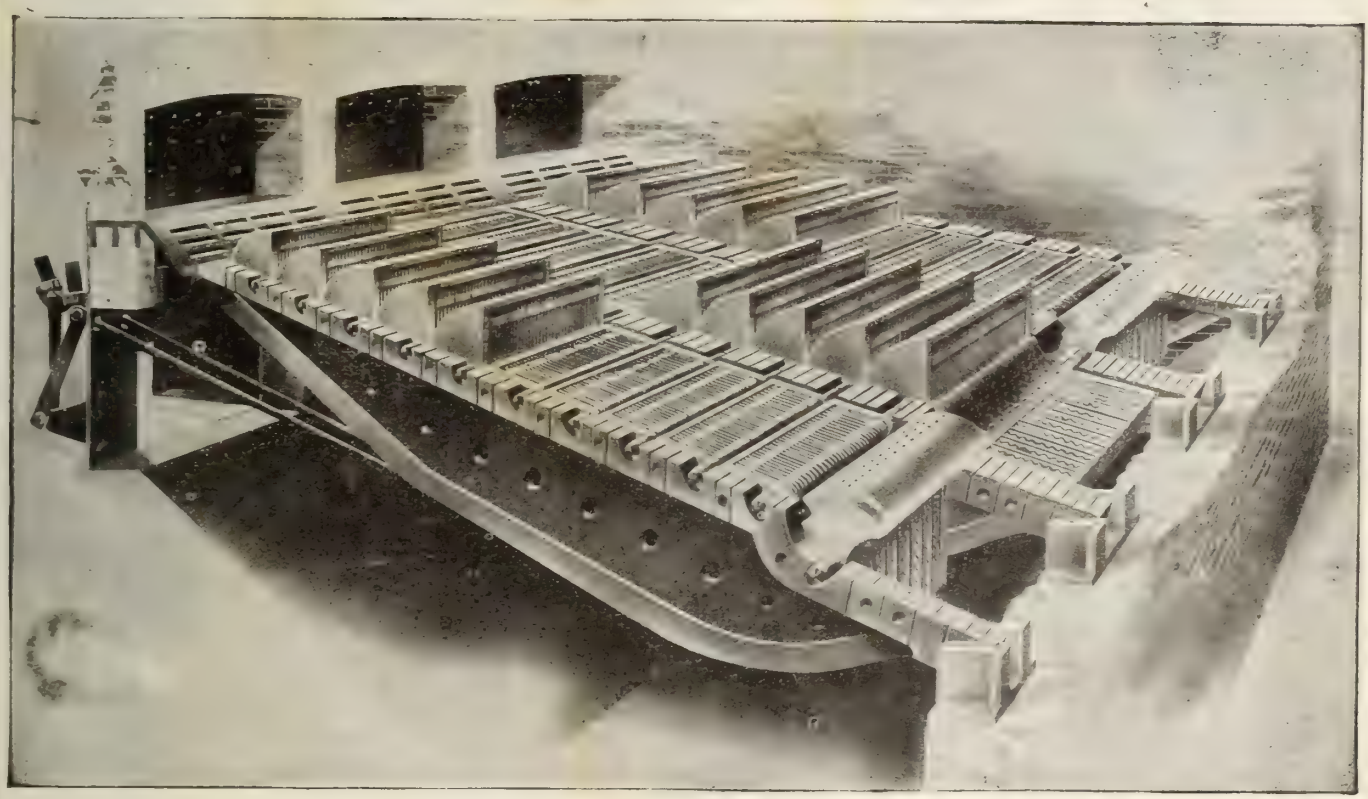

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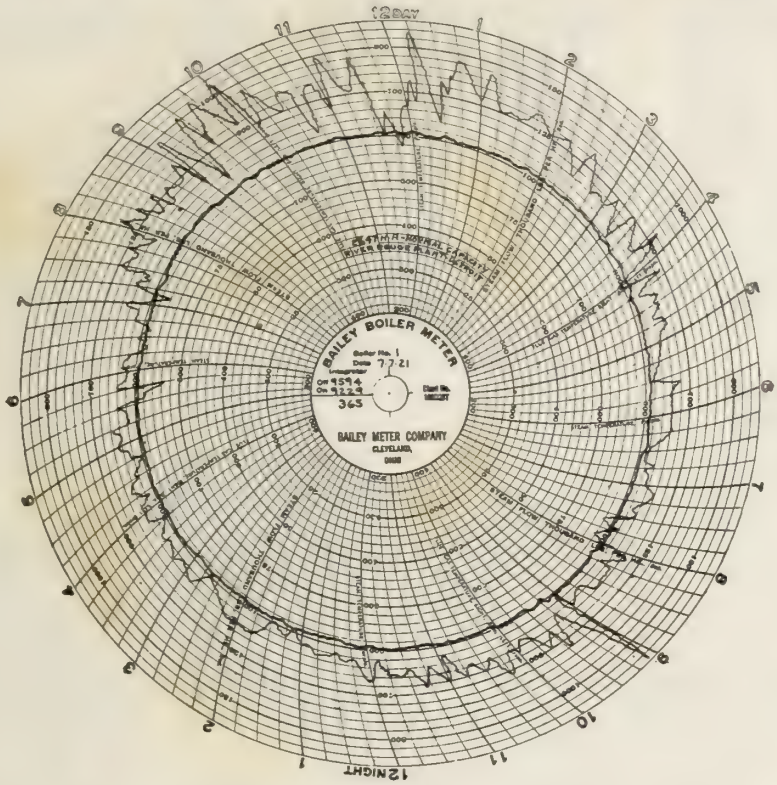
Constant Steam Temperatures Maintained with ELESCO Superheaters at the Ford Motor Company, River Rouge Plant



Maintenance of superheated steam temperatures nearly constant under a wide range of boiler loads, is shown on the above chart taken from one of the 2,647 H.P. boilers at the River Rouge plant of the Ford Motor Company.

The outside irregular line indicates the steam flow, which under normal operation at 100% boiler rating is 82,586 lbs. per hour. It will be seen that this varies from 163,000 lbs. maximum 197.5% rating to 84,000 lbs. minimum 101.6% rating.

The even inside line indicates steam temperatures. At normal pressure (225 lbs. gauge) the approximate temperature of 200 deg. superheat is 600 deg. F. It will be noted that the variation in steam temperature, from 615 deg. maximum to 588 deg. minimum, is but 4.5%.

Correctness in design and location of ELESCO Superheaters reduce the variations in steam temperatures to a negligible quantity.

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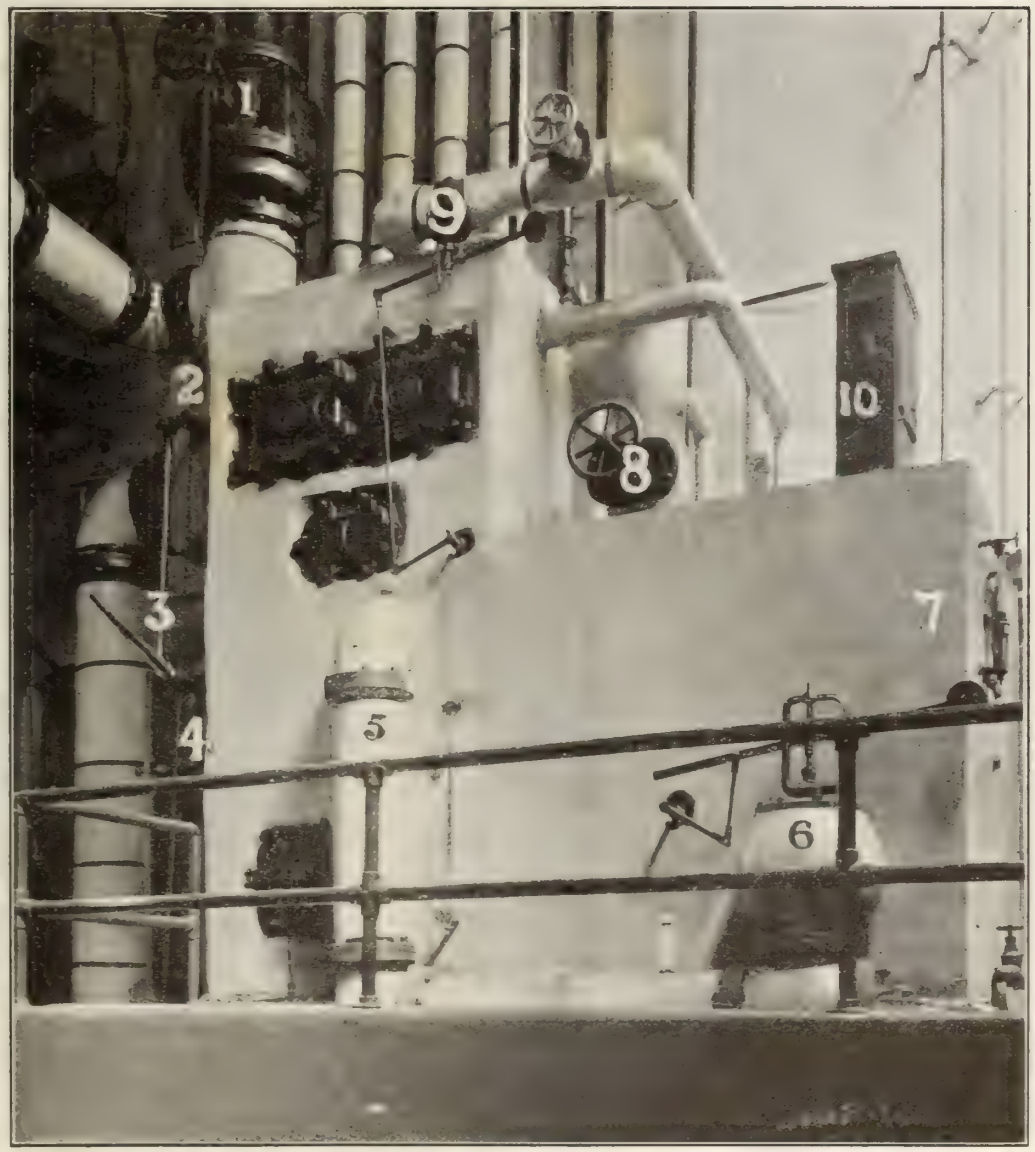
"TO ECONOMIZE-COCHRANIZE"

COCHRANE

Combined Boiler Feed Heater and V-Notch Meter

in the Plant of the Toronto Carpet Company



1. Cochrane Multiport Safety Exhaust Valve.
2. Cochrane Oil Separator with cut-out Valve.
3. Cut-out Valve mechanism.
4. Cochrane Oil and overflow trap.
5. Pipe connecting Heater and Meter chambers; bypass direct from Heater to Pump provided.
6. Equalizing Valve to Meter chamber.
7. Zero Indicator.
8. Equalizing Valve connecting Heater and Meter chambers.
9. Balanced cold water regulating Valve.
10. Cochrane Recorder with Flow Indicator and Integrator.

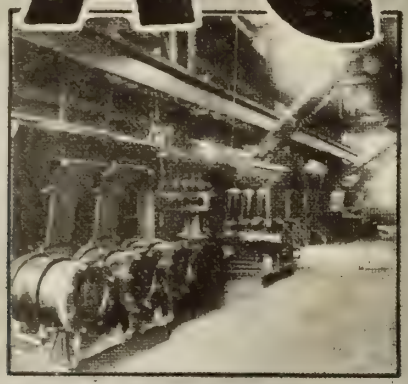
CANADIAN ALLIS-CHALMERS LIMITED

TORONTO, ONT.

Sole Canadian Agents for

H. S. B. W. COCHRANE CORPORATION

Jones "A-C"



High-Duty Stokers

—for heavy overload capacity

THERE is no safer index of stoker performance than ability to meet and sustain heavy overloads. For the stoker that will not carry heavy overloads, is almost invariably lacking in other essentials of economical operation. Heavy overload capacity is an inherent advantage of under-feed stoking, that basic principle originated and perfected in Jones Stokers. No ignition arches are needed for under-feed stokers, so the full radiant effect of the heat is obtained.

Jones "A-C" retorts hold 50% more coal. Consequently volatilization is complete even at highest over-ratings. Eight ranges of fuel and air supply insure highest efficiency for all combustion rates. The elimination of troublesome clinker formation, coupled with rugged simplicity of design, insures year round overload capacity.

The heavy overload capacity of Jones "A-C" Stokers often makes the installation of additional boilers unnecessary when the load is greatly increased through plant expansion.

Write for the "A-C" catalog.

Made in Canada

All Jones Stokers are made in Canada by Canadians and sold for Canadian money at par.

Under-Feed Stoker Co. of Canada, Ltd.

146 King Street West, Toronto

British Columbia:
[illegible]

Alta. and West. Sask.:
Mr. J. Twomey,
Camrose, Alberta.

Que. and Mar. Prov.:
[illegible]
Montreal, Que.

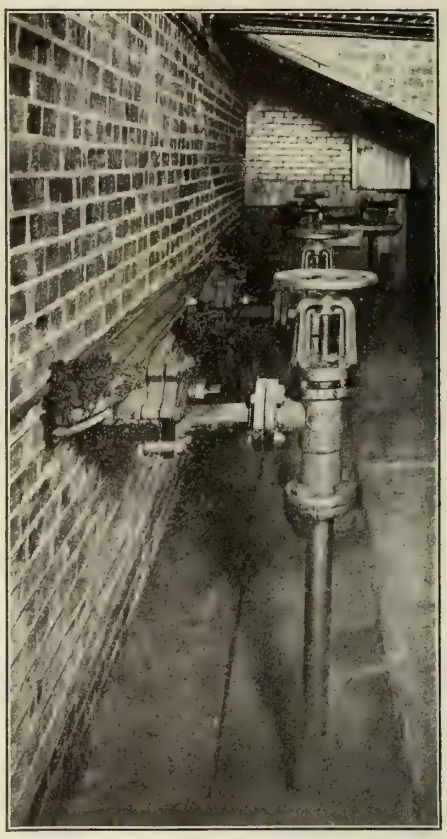
Man. and East Sask.:
W. W. Hicks & Co.,
Winnipeg

Toronto Carpet Co.

uses and prefers

YARWAY

Seatless Blow-off Valves



The thoroughly modern power plant of the Toronto Carpet Company, described in an editorial article in this issue, is equipped with the blow-off valve that has no seat to leak — the YARWAY SEATLESS.

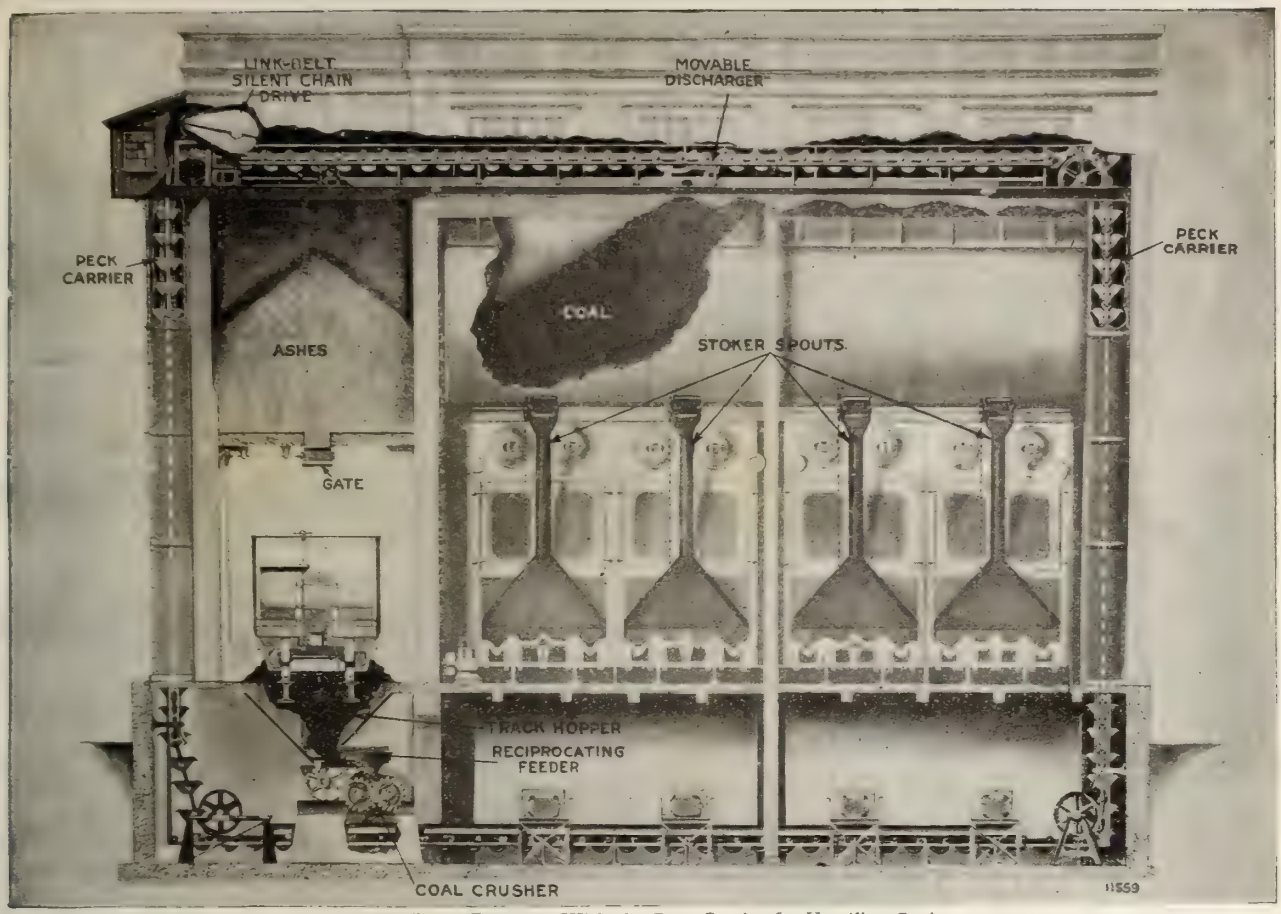
Each of the four boilers in this plant is equipped with two YARWAY SEATLESS BLOW-OFF VALVES.

Careful operators in hundreds of plants throughout Canada and the United States prefer this valve for blow-off service. Used in tandem with its companion, the Yarway Double-Tightening Valve, it is especially popular. Booklet B-410 gives the reasons for this widespread popularity —tell us where to send your copy.

YARNALL-WARING COMPANY

Mermaid Ave. and Ardleigh St.

PHILADELPHIA



Boiler Room Equipped With the Peck Carrier for Handling Coal and Ashes

FOR EFFICIENT POWER PLANT OPERATION, REMEMBER

—That there is just as much opportunity for effecting economies by the proper handling of the coal and ashes, as in the actual generation of steam.

—That the Peck Overlapping Pivoted Bucket Carrier is the most dependable and economical machine for this purpose.

—Our experienced engineers are ready to assist you on your handling and storage problems.

Send for Book No. 220—The Peck Carrier.

We also make:

Track Hoppers
Coal Crushers
Coal Bunkers
Weigh Larries
Gates and Chutes
Drag Scrapers
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Portable Conveyors
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Made in Canada

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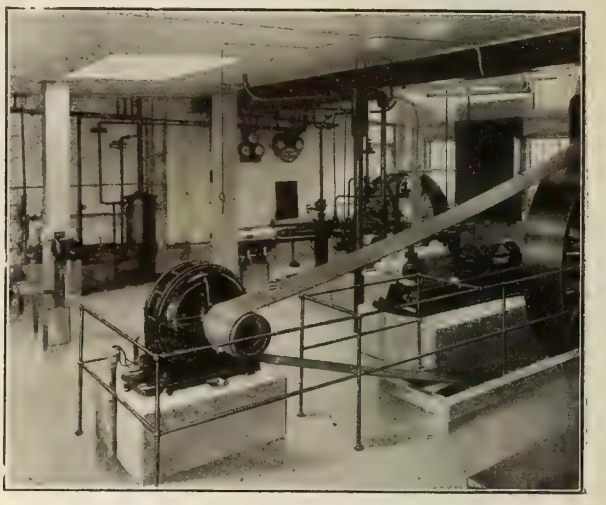
For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

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TORONTO WINNIPEG VANCOUVER

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

CANADIAN PLANET ENGINEERING COMPANY LIMITED

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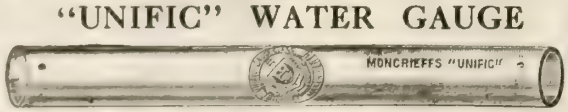
Manufacturers of

PLANET MECHANICAL SOOT BLOWERS

Dealers in power plant specialties, mechanical and hand-fired stokers, valves, steam and vacuum traps, gauges and recording instruments, refrigerating machinery.

MONCRIEFF'S

"UNIFIC" WATER GAUGE



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Moncrieff's "Unific" is not a cheap glass. But because it outlasts many ordinary glasses the "Unific" is economical. Britist Made

JOHN MONCRIEFF LIMITED

PERTH, SCOTLAND

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

The Best Equipped Plant for Refrigeration Work in Canada.

YORK Refrigerating Machines have reached that stage of development where every objection formerly held against the installation of mechanical refrigeration has been entirely removed.

These machines are known as our Vertical Single-Acting Enclosed Type. The unit system of production is used throughout so that standard equipment and parts are readily interchangeable.

In the manufacture of York Machines the most rigid system of inspection is maintained to insure uniformity of quality.

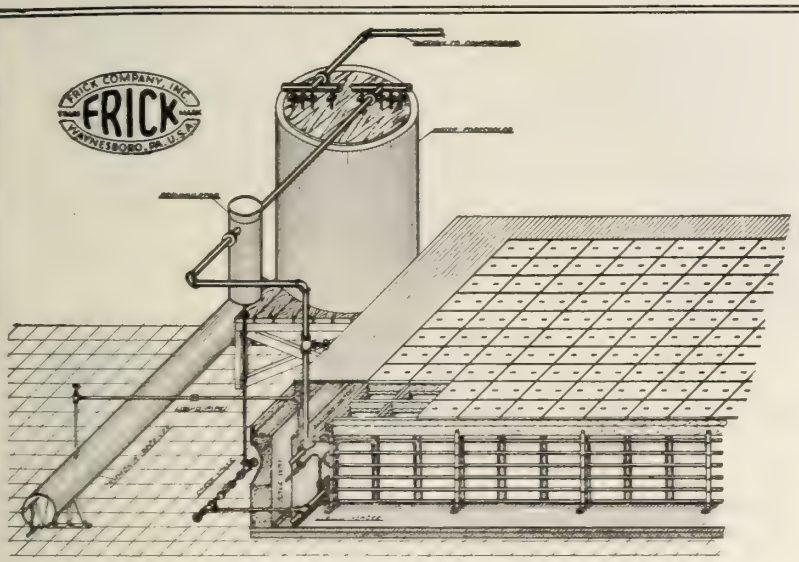
A further asset to the users of York Equipment is the service rendered by the York Sales Organization where any information on refrigerating problems may be had for the asking. Get in touch with

CANADIAN ICE MACHINE CO. LIMITED

Toronto: Villiers and Munition Sts., Eastern Harbor Terminals. **Montreal:** 324 Craig St. West. **Winnipeg:** 1415 Whyte Ave. **Vancouver:** 1158 Homer St.

YORK MANUFACTURING CO., YORK, PENNA. U.S.A.

Ice Making and Refrigerating Machinery Exclusively



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Is a STANDARD Part of Every FRICK Plant

Its simplicity and dependability have made it a standard known the world over. Its success is unqualified.

It

Simplifies plant operation by reducing the number of feed valves to be regulated.
Increases plant efficiency by insuring uniform operation and giving absolute control of the ammonia.
Adds to plant safety by preventing priming accidents.
Lowers first cost of plant by increasing the heat transfer through the evaporating surface, thus reducing the amount of surface required.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1852
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose —all types: Vertical—Horizontal—Absorption.

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HEAVY DUTY
Cold Storage Doors
Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

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HAGERSTOWN - MARYLAND, U.S.A.

Better tools make better workmen
And there are no better tools than
WILLIAMS'
SUPERIOR DROP-FORGED HAMMERS
All Kinds; All Sizes.
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"The Drop-Forging People"
78 Thorold Road St. Catharines, Ontario.

USE LESS FUEL

You can do it, while at the same time producing more power, if your boiler settings—arches, side and bridge walls and baffles—are made of

PLIBRICO JOINTLESS
FURNACE LINING

There is no chance for air or gas leaks through a PLIBRICO setting, therefore less fuel is needed to obtain the objective desired—the production of steam.

Not only does PLIBRICO permit the production of more steam at less cost, but it forms boiler settings that last from two to four times as long as laid-up fire brick, and that are impervious to heat up to 3,100° F.

A complete PLIBRICO setting is a paying investment. Our book, L-68 on "Modern Furnace Building," gives full information. Ask for it, and ask also to have our nearest representative call.

Our service is free.

PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.

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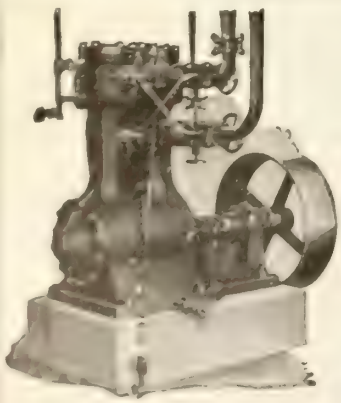

Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada
CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company
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Just out—send for yours

IT'S the new Reliance catalog, just off the press. There's a copy for you.

It contains full information on Reliance products—how they are made, installed and operated, illustrated with sectional views and photographs.

Besides, it contains a lot of data valuable to engineers, put so you can grasp it instantly.

Tear off the coupon and mail it—now, while your hand's on it.

THE RELIANCE GAUGE COLUMN CO.
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Please send that new catalog to
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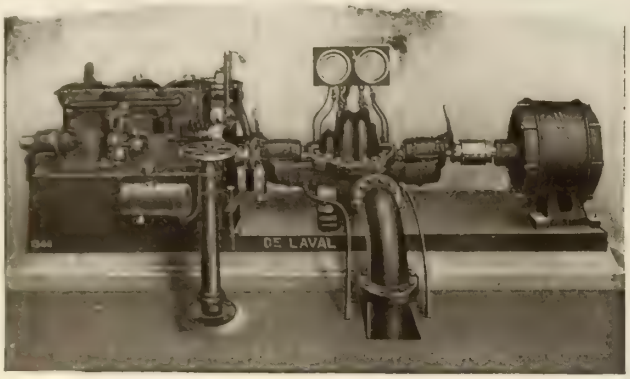
P. H.

Duplicate Power Supply For Pumping



Ask for our complete catalog B-103

THE De Laval centrifugal pump shown herewith was built for the City of Lindsay, Ont., and is arranged to be driven either by an induction motor, or, when electrical power is not available, by a 6-cylinder gasoline engine. A clutch is provided for disconnecting the engine when not in use. The unit is rated at 1,325 gal. per min. at 1,450 r.p.m. With a duplicate power supply there is practically complete assurance of being able to deliver water at all times. The characteristics of De Laval centrifugal pumps are ideal for such service, as there is practically zero starting torque, and, due to the power-limiting characteristic, the De Laval pump cannot possibly overload the motor.

DE LAVAL STEAM TURBINE CO.

TURBINE EQUIPMENT CO., LTD., 73 King St. West, Toronto

THE E. LAURIE COMPANY, 243 Bleury St., Montreal, Que.

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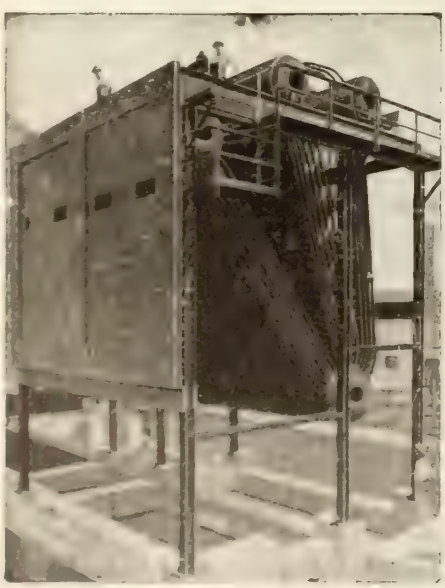

Connelly Water Tube Boilers

are of the 4-drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H.P. up to 4,000 H.P. and 300 lbs. pressure. Over 150,000 H.P. in successful operation.

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Wm. W. Hicks, 567 Banning St., Winnipeg, Man.
George Stewart, 5 Lineham Block, Calgary, Alta.
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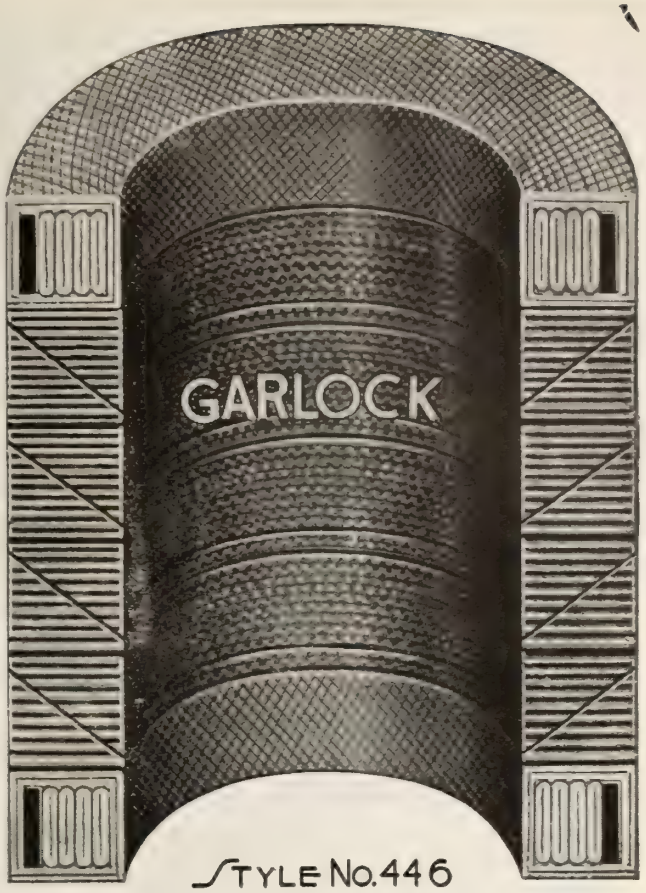
LEONARD

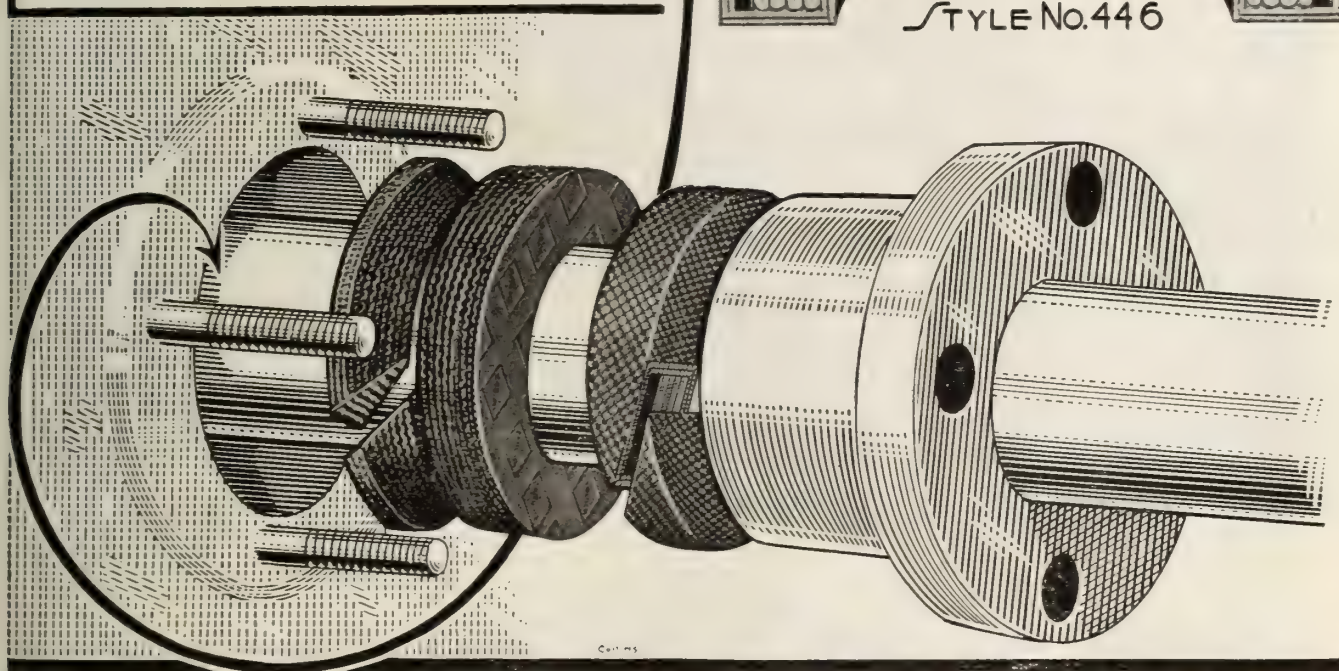
The Polished Rod

The much desired "glass-like" polish on piston rods can only be maintained by the use of a packing that retains its elasticity and lubricant—not for a few hours after repacking, but during long service of changing pressures and temperatures. Rings of Garlock High Pressure Packing combined with our Diagonal Ring Packing makes a combination (Style No. 446) particularly adapted for service against medium or high pressure steam.

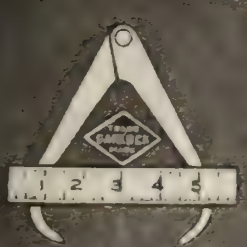
This combination will retain the polish and

"Spare the Rod"





GARLOCK PACKINGS



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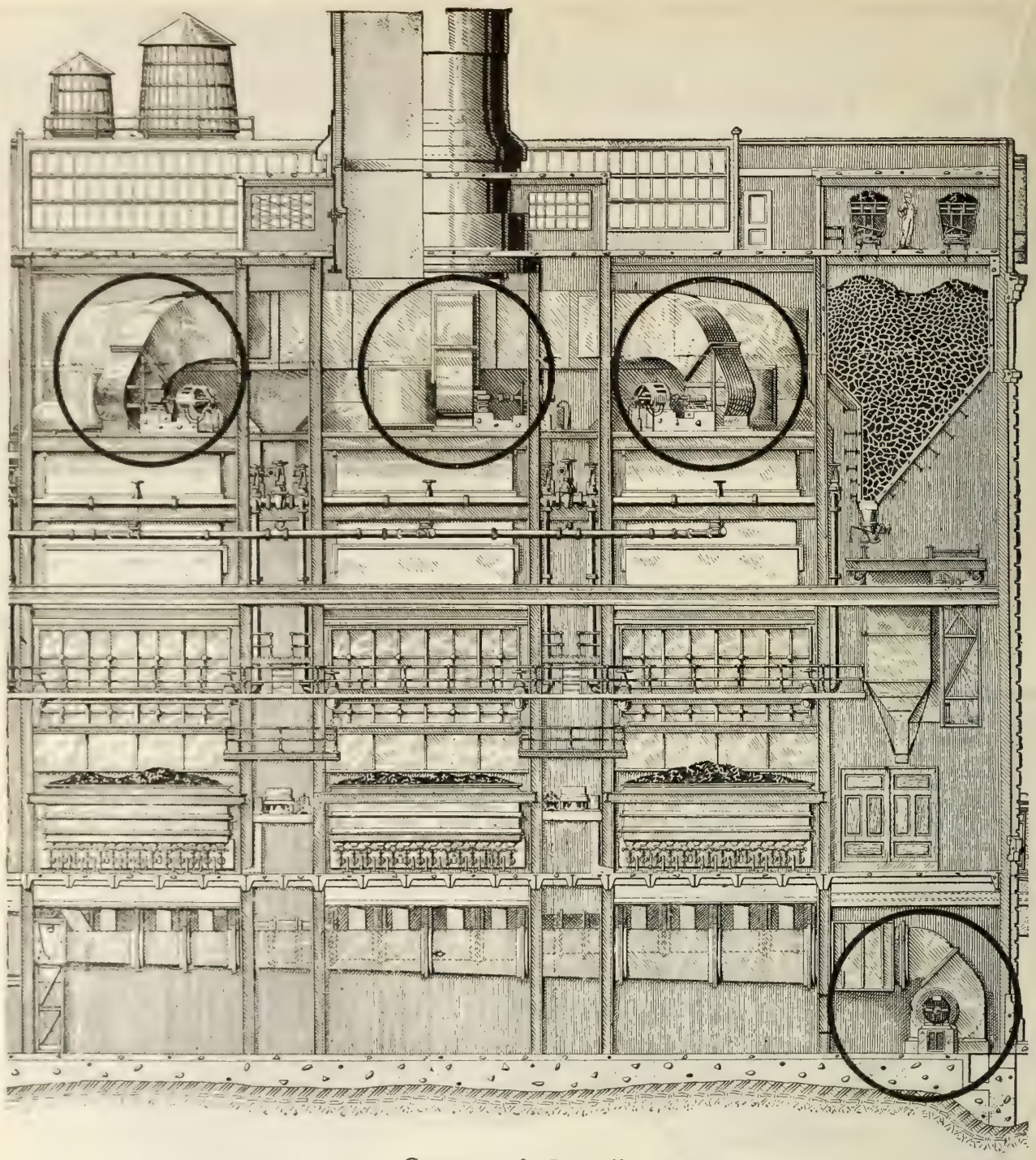


Courtesy of "Power"

FORCED AND INDUCED DRAFT AT HELL GATE

The above shows the location of Sturtevant fans and the important part they have in boiler plant operation.

At present there are eight of these forced draft and twelve induced draft fans in this station, all direct-connected to brush-shifting motors.

The completed layout calls for one forced and one induced draft fan for each of the twelve boilers.

In this, the world's largest power plant, as in other representative installations, it is Sturtevant apparatus that is usually included.

B. F. STURTEVANT COMPANY OF CANADA, LIMITED

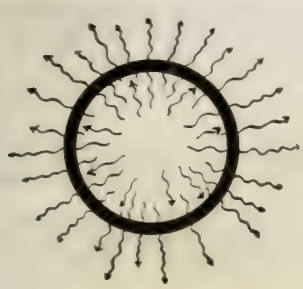
TORONTO GALT MONTREAL

TERRITORIAL REPRESENTATIVES:

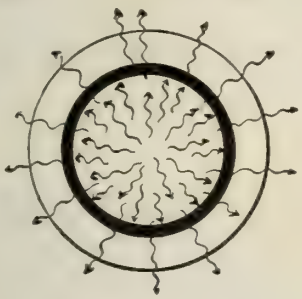
Empire Engineering & Supply Co., Edmonton, Alta. Kipp Kelly, Ltd., Winnipeg, Man. 676

What pipe insulation efficiency means

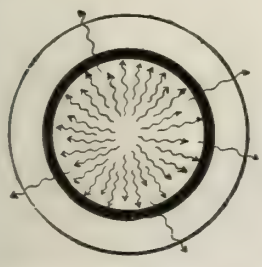
Pipe insulation efficiency is the percentage of the bare pipe heat loss which is saved by the insulation. It varies with pipe size, insulation thickness, and temperature difference.



1. This represents bare pipe. The heat loss, as represented by the escaping arrows, is maximum. The efficiency is zero.



2. Low grade "pipe covering." This may look like high-grade insulation but the heat knows the difference. Too much heat escapes — efficiency is low.



3. Johns-Manville Asbesto-Sponge Felted Insulation. In a test of 26 heat insulations conducted at the University of Wisconsin, this insulation led all others in efficiency.

Buy pipe insulation efficiency —not just pipe covering

IN selecting pipe insulation, the careful buyer never forgets that one consideration dominates all others — permanent insulation efficiency. Obviously, this is the quality that actually pays dividends in economy.

Initial efficiency, unless maintained year after year, means nothing.

That is why the permanent high efficiency of Johns-Manville Asbesto-Sponge Felted Insulation is so important. Impartial tests (such as those conducted at the University of Wisconsin) have repeatedly shown its construction the most efficient on the market.

In Asbesto-Sponge, the thin laminations of indestructible asbestos fibre carry countless dead-air cells formed by the imbedded spongy material. These cells and the dead-air spaces between laminations form an unusually effective heat barrier.

But of equal or even greater importance is the fact that the construction is exceptionally strong which assures durability. Dampness, shocks and vibration leave it unharmed — you can even hit it with a hammer.

Asbesto-Sponge retains its high efficiency indefinitely. For that reason it is most economical.

Canadian Johns-Manville Co. Limited

Toronto Montreal Winnipeg Vancouver Windsor Ottawa

COVERS THE CONTINENT

Through—

Asbestos

and its allied products

INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE

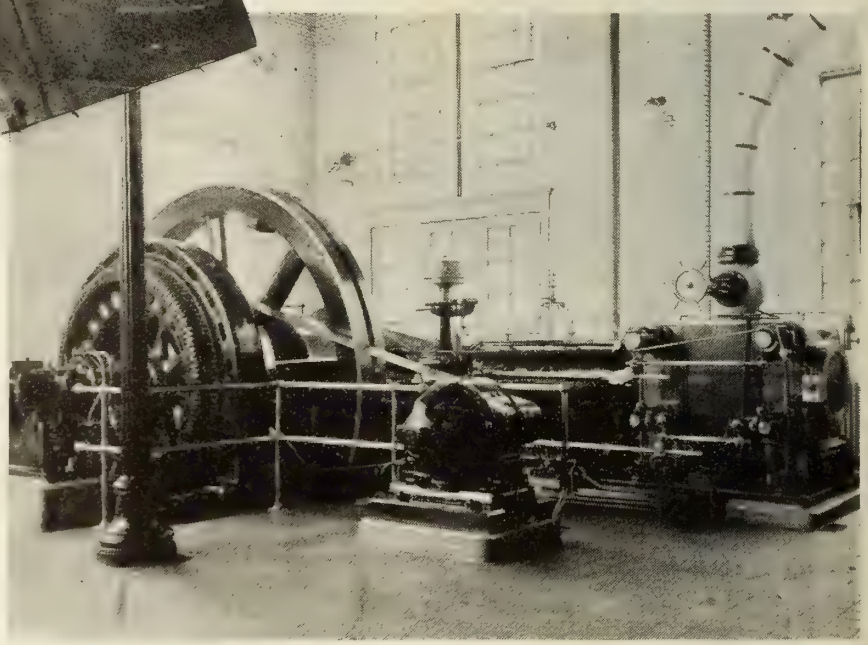
Power Plant Materials

DEPENDABLE POWER EQUIPMENT

GOLDIE & McCULLOCH EQUIPMENT

Installed in the Power Plant of the Toronto Carpet Company

G. & McC. Sectional Water Tube Boilers of 412 Horsepower each.



Heavy Duty G. & McC. Corliss Steam Engine.

Write for Catalogue, Prices and Detailed Information

G & McC. Se tional Water Tube Boilers are built to meet the demands of the largest plants. Greater combustion area and increased steaming capacity are two important features that distinguish them from ordinary boilers—**they can be forced** w thout danger.

G. & McC. Corliss Engines are well known to leading engineers of Canada for the exce'lence of their general design and perfection of materials and workmanship. They are the logical selection for big plants similar to that of the Toronto Carpet Company. There are many points of superiority about them which make them also the most desirable engines **for plants of every size.**

The GOLDIE & McCULLOCH COMPANY LTD.

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POWER HOUSE

Members of the Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

One of Toronto's Outstanding Power Plants

The Toronto Carpet Manufacturing Co. Has a Power Plant Which is Modern in Every Respect—Everything Necessary in the Way of Recording Instruments Are Installed and Appearances Have Been Well Looked After

By T. H. FENNER

AMONG THE industries that have been developed in Canada during the last few years, and are now assuming healthy proportions, the carpet and cloth making industry holds an important place. There was a time when one thought of cloth for garment purposes, and carpets for domestic use, as purely imported materials, but such is no longer the case. While the greater part of these goods are still imported, there is a constantly increasing proportion being manufactured in Canada.

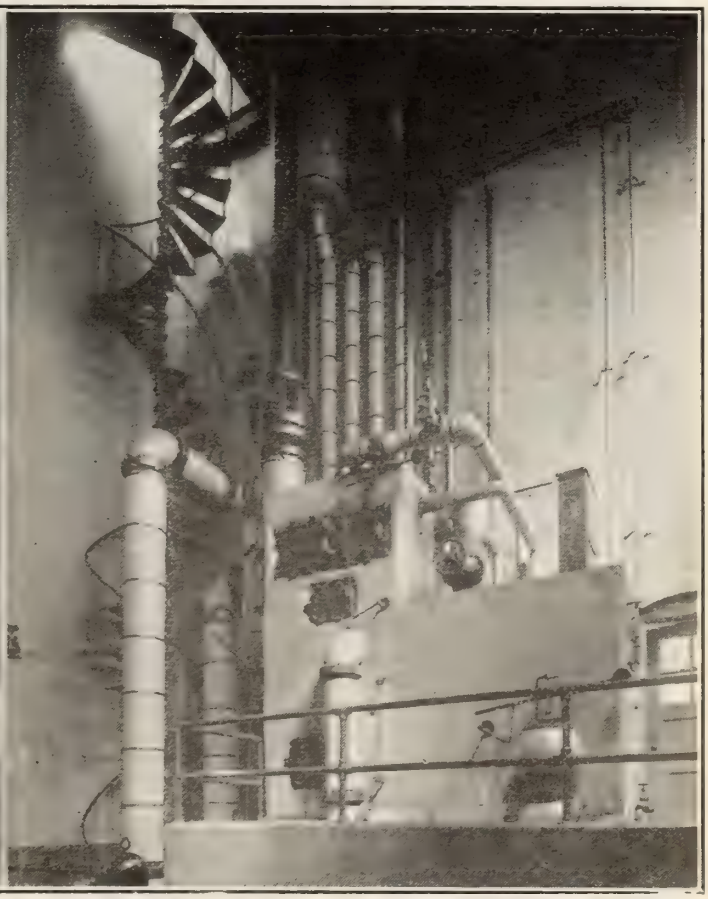
Among the largest manufacturers of these two staples, the Toronto Carpet Manufacturing Co., King Street, Toronto, occupies a prominent place. Part of the premises are devoted to the manufacture of carpets, and part to the production of "Barrymore" cloth. Two very important requirements for a factory of this kind, are power for the looms, and steam for heating water, drying, and various processess entering into the manufacture, as well as steam for heating the premises during the winter months. To take care of these requirements, a very modern steam and electric generating power plant has been installed, and this in addition to a certain amount of power purchased from the Hydro Commission, amply performs the duty.

The general design was prepared by Mr. M. F. Thomas, consulting engineer for the Toronto Carpet Manufacturing Co., while the general contractors were the Wm. Steele and Sons Co. The plant is an interesting example of a modern industrial power plant of medium size, and is convenient in arrangement, while providing ample room for the equipment contained in it.

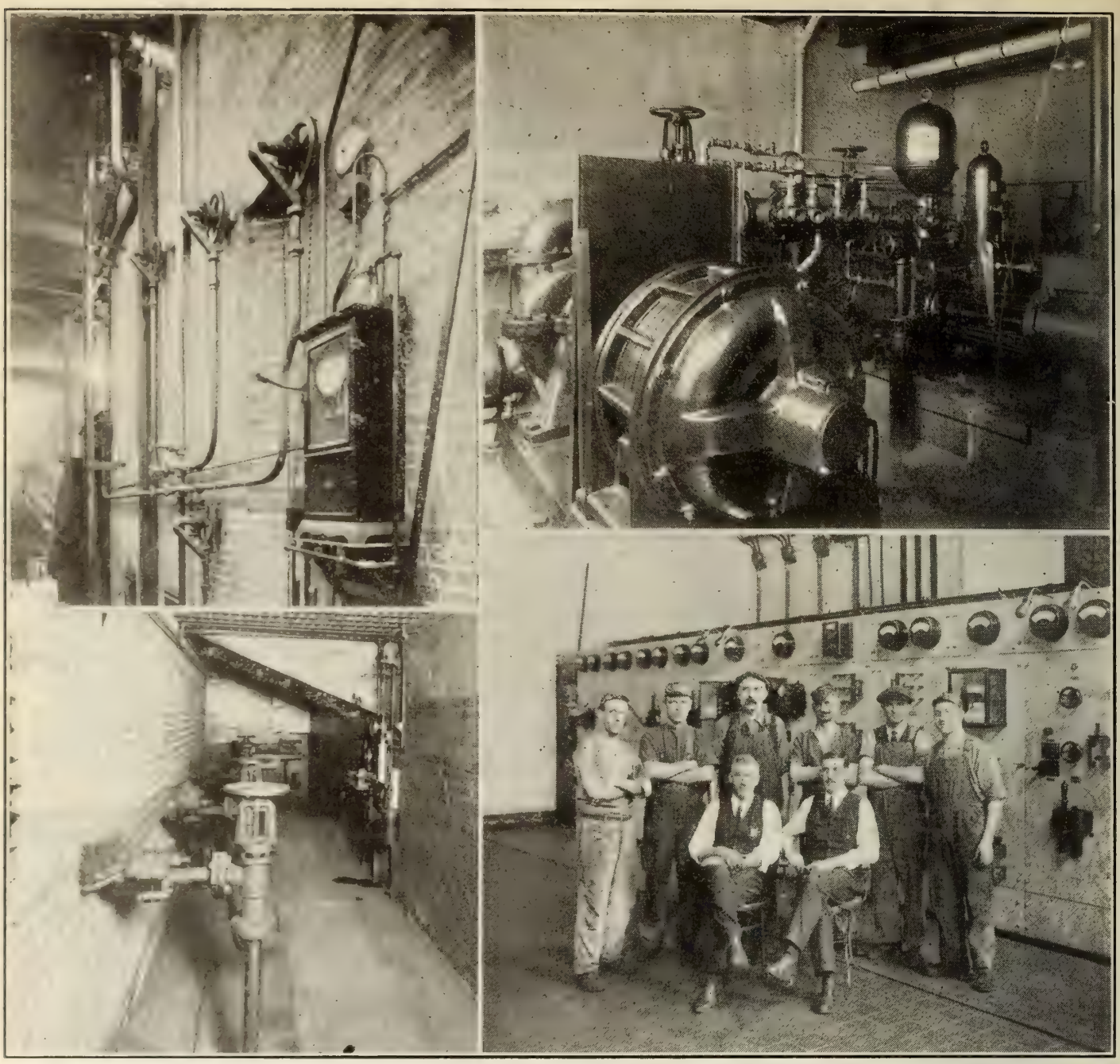
The General Arrangement

The power house building is in shape like an L, the engine room being the

Outside View of Power House



Corner of pump room showing heater and spiral stairway



Upper Left: Side wall of boiler showing Diamond Soot Blower and Hay's CO2 recorder. Upper Right: Centrifugal and reciprocating fire pump units. Worthington centrifugal and Buffalo reciprocating. Lower Left: View at back of boilers, showing Goldie & McCulloch and Yarway blow down valves. McDonough damper regulator on wall. Lower Right: Seated on left Mr. Farrar, Chief Electrician; right Mr. W. Clark, Chief Engineer; standing left to right, Messrs. Lloyd, Griffiths, Ransome, Gould, M M., Sellers and Strain.

short leg of the letter. The engine room is on the ground level, and the door in the front of the building shown in the photograph leads direct into the centre of the room. The height can be seen from the outside view, while the photograph showing the engine gives clear evidence of the light available.

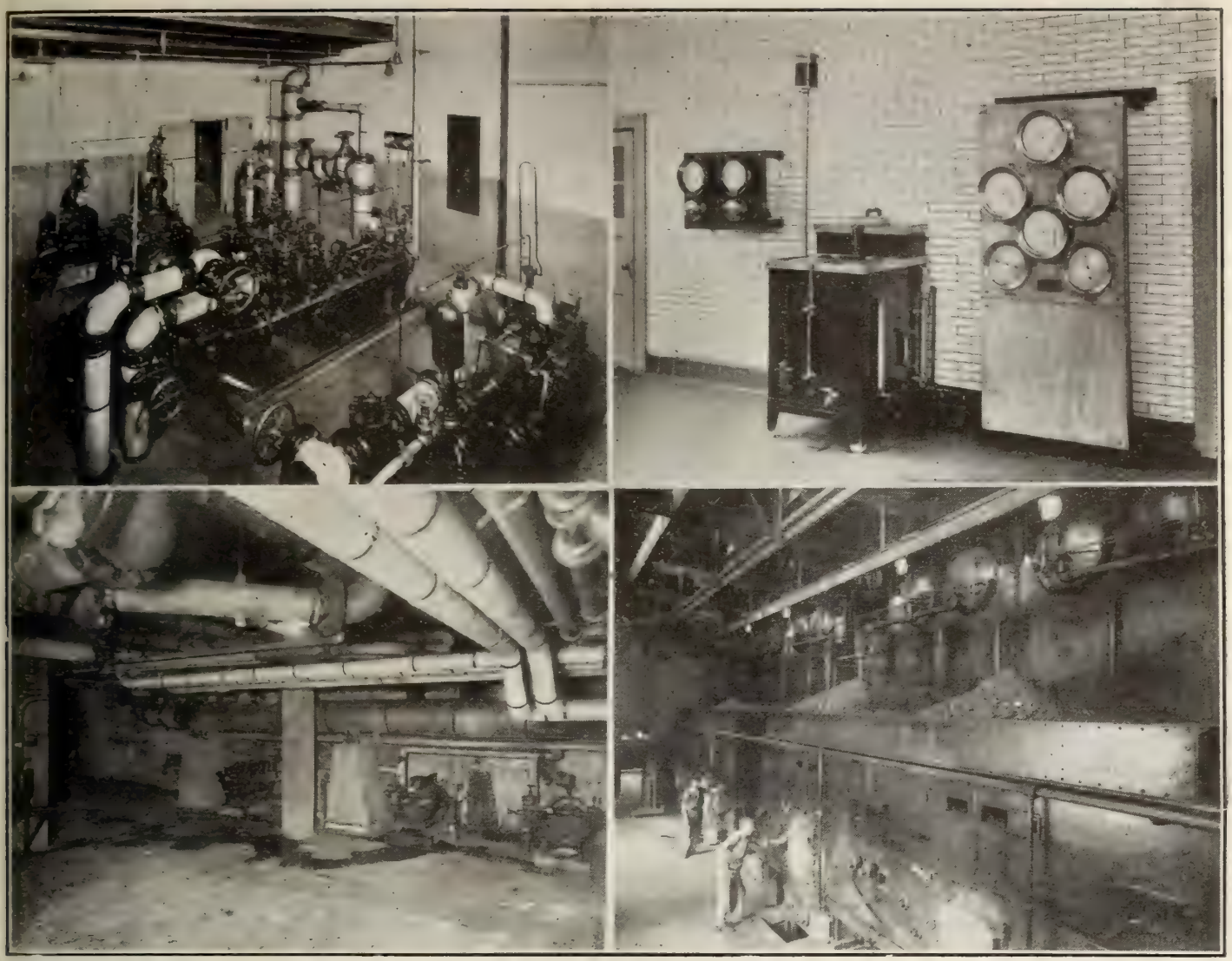
Behind the engine room, in the main part of the building is the pump room, which is divided in two, one portion containing the feed and vacuum pumps, while a separate chamber in the rear houses the fire pumps. There is also a wash room, containing shower and all conveniences, in the rear of the pump room, and divided off by a partition. The pump room level is about six feet below the engine room level, a fact which gives the opportunity to have the heater just inside the pump room partition, but on the same level as the engine room floor, and thus well above the pump room, and pump suctions.

The boiler room, which is divided from the pump room by a strong wall, making it practically self contained, is on the same level as the pump room, and a door leads between the two. The front wall of the boiler room contains four large openings, opposite each wall of the boilers, which can be closed by a metal screen, on rollers, or left wide open in the warm weather. The extreme right hand opening can be seen in our photograph, to the right of the engine room. The proximity of office and factory buildings prevented our photographer from getting a full front view of the engine and boiler rooms. This plant is situated right in the centre of all the buildings, which position, while very desirable from a utilitarian point of view, does not lend itself to getting a satisfactory photograph.

There is a basement under the pump room, which extends also under the boiler room, and contains the lower run of the conveyor, and a tunnel for the piping going to the factory.

The Boiler Room

The boiler room is well equipped with recording and indicating instruments and coal and ash handling machinery, which will be described in detail. The boilers themselves are four in number, contained in two batteries of two each. They are of the Goldie and McCulloch water tube type, made by the Goldie



Top Left: Pump room looking from heater platform. Wheeler and Worthington feed pumps, and in back ground, Burnham vacuum pumps. Top Right: Recording flow meter dials on left, oil filter, and recording thermometers, pressure gauges and vacuum gauge or large panel. Bottom Left: Basement under pump room, showing steam and exhaust piping, return traps, and flow meters. Bottom Right: View of boiler room, showing boiler fronts, stoker hoppers and traveling weigh lorry. Coal bunker overhead.

and McCulloch Co. Galt, Ont., and each boiler is equipped with a Murphy automatic stoker. operated by a small steam engine situated at the side of number one boiler. The boilers work at 125 lbs. pressure the safety valves being set to blow at 135 lbs. The air for combustion is supplied by natural draught. the chimney being 150 feet above the grate level, and maintaining a vacuum in the furnace of .15 in. to .25 in., according to the way the boiler is being worked.

The boilers are of the double drum type the rated horse power of each being 440 but of course. they can be worked to ratings considerably higher than this if the necessity arises. At the time of our visit, only three of the boilers were on the line, one being down for cleaning. and this is the usual method of working.

On the front of each boiler there is an Ellison differential draught gauge, and in addition there is a Hay's CO_2 recorder for each boiler. The method of mounting this instrument can be seen in the illustration the four instruments being set in the same way on each boiler. In addition to the CO_2 recorders there is a General Electric steam flow meter connected to each boiler, the dials being arranged in pairs at each end of the boiler room, so that the boiler operators can see them from any position on the firing platform.

The damper regulator, which is made by the McDonough Damper Regulator Co. is mounted on the back wall of the boiler room, where it is in a convenient position for examination, and yet not liable to be damaged. The space at the back of the boilers, as can be seen in the illustration, is wide enough to allow the men to move around with ease, and it will be noted that the boilers are set high enough to keep the blow off valves well clear of the ground. The illustration shows one half of the blow off valves, the photograph being taken from the passage dividing the two batteries of boilers. There is a Goldie and McCulloch blow down valve next to the boiler, and a "Yarway" sleeve type valve on the outside on each blow down pipe. There are two pipes on each mud drum.

Each boiler is fitted with the Diamond Valve-in Head soot blower, the arrangement of the units being plainly seen in the illustration. Steam for these units is taken from the end of the equalising pipe connecting the drums on each boiler, thus ensuring practically dry steam.

The steam connection from the boilers to the main header, are made through large expansion bends, in the usual way. The boiler tops are reached by a substantial iron ladder at either end of the boiler room. There is ample space in front of the boilers, as can be seen in the photograph. The Ellison draught gauges can be seen on the boiler fronts just above the furnace door.

The Coal and Ash Equipment

There is a complete conveyor equipment for handling the coal and ash, installed by the Canadian Link-Belt Co. There is no handling of the fuel from the time it reaches the yard, until the remaining refuse leaves the yard in the form of ash. This means that the conveyor equipment receives the coal, elevates it to the storage bunker,

View on top flight of coal conveyor above bunker

weighs it before delivering to the stoker hoppers, and picks up the ash from the ashpits, taking it to an ash bunker where it is stored until the car or waggon is ready to take it away. The main unit of the conveyor is known as a Peck Pivoted Bucket Conveyor. It is really an endless chain, on which buckets are fastened at regular intervals in such a manner that they are free to pivot, thus keeping horizontal while travelling up or down the leg at each end, or on the horizontal run of the conveyor. The buckets are 25 inches long by 18 inches wide, while the pitch of the chains is 24 inches. At each joint there is a special chilled roller, 6 inches diameter, which can be seen very plainly in the illustration showing the upper run of the conveyor over the bunker. The rated capacity of the conveyor, when handling coal is 50 tons per hour, but this rate can be exceeded, this particular conveyor having handled seventy tons in seventy minutes, or about 20 per cent. above its rated capacity. Owing to the balance maintained between the buckets moving up and those moving down, there is but little power required, a 7½ h.p. motor being sufficient to operate the conveyor, as shown in the illustration.

The outline drawing shows the general arrangements and sequence of events in handling the coal and ashes. The coal comes into the yard in hopper bottom cars, and is dumped into a receiving hopper right in the track. This hopper has sufficient capacity to take care of the average gondola car. From the hopper it is fed into the crusher, when the coal is of large size, but if the coal is received small enough for stoker purposes the crusher can be bypassed, and the coal fed directly into the Peck conveyor. The crusher is of the two roll type, having 26 inch by 24 inch hard rolls, and is driven by a 15 h.p. motor.

The Peck conveyor picks the coal up from the crusher, and carries it to the overhead bunker. A somewhat unusual condition was present in this installation, which prevented any of the conveyor machinery being placed above ground outside the railway track. The arrangement shown in the drawing was adopted to overcome this. It will be noticed that the chain is carried out past the crusher over two guide sheaves, and back again horizontally to the leg going up outside the boiler room wall.

Coal is unloaded at any point in the overhead bunker by means of a travelling dumper. This is a form of stop, which can be placed at any position on the track required, and causes the buckets to tip up in order to pass over it, thus dumping their contents. As soon as they pass the dumper, they resume their upright position.

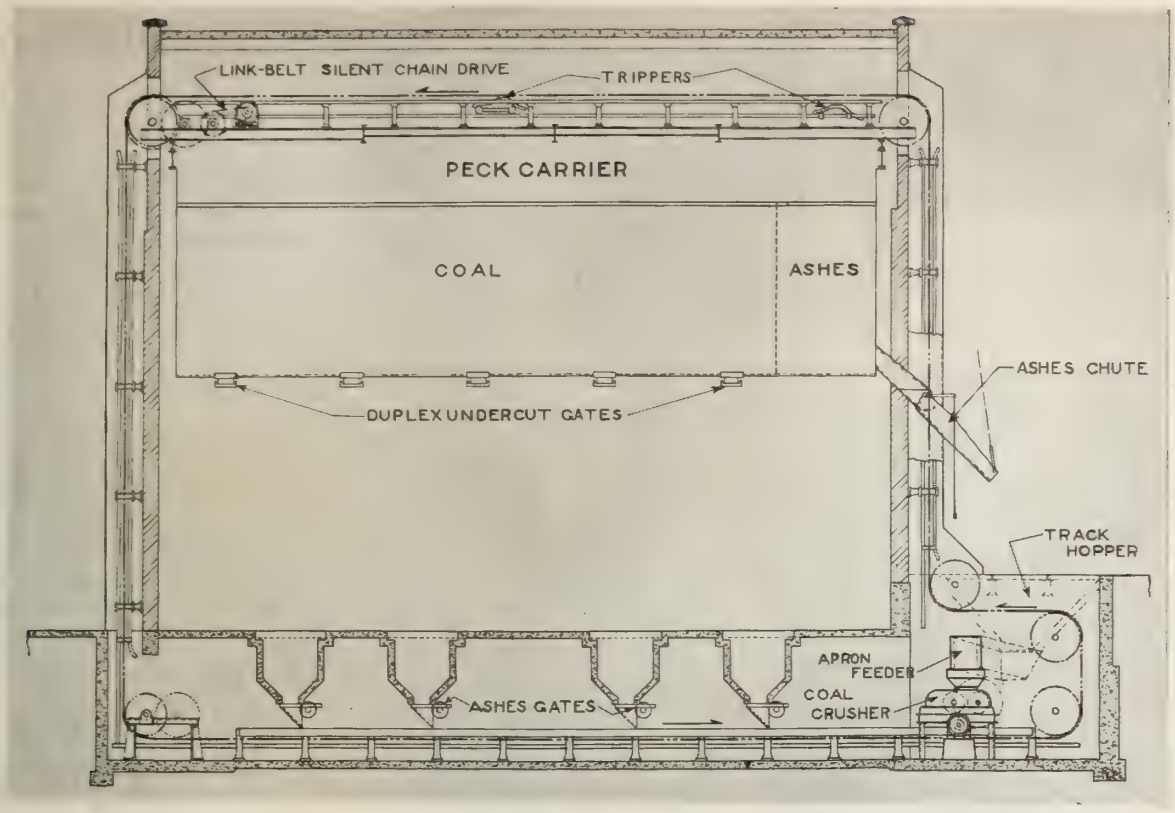
The ash bunker is situated at the far end of the bunker, nearest the wall, and when carying ashes the dumper is of course set at the extreme position. A chute leads from the bunker by means of a travelling larry which weighs the coal, its capacity being 1,500 lbs. The gates on the bottom of the bunker from which the coal is drawn are so arranged that they cannot be opened unless the larry is in position underneath them. This is achieved by building the mechanism for opening the gates into the top of the travelling larry.

The ashes are discharged from the back end of the Murphy stokers into the ashpit which opens into the tunnel, and gates are provided by which the ashes can be picked up at any point by the conveyor. The illustrations convey the general idea very clearly.

The Pump Room

Passing through the dividing door from the boiler room, we find ourselves in the pump room. This room contains the feed and vacuum pumps, and the heater, while the fire pumps are contained in a separate chamber of the main pump room.

The first thing that strikes one's eye, is the arrangement of the heater, and the delicate tracery of the winding stair that looks as though it went up indefinitely. Our photographer was successful in getting an excellent view of this stairway, and the heater, from the floor of the pump room. The reader can form a good idea of the position of the heater with relation to the pumps by noting the top of the air vessel of the nearest pump just showing in the photograph. This stairway was made by



The general arrangement of coal and ash conveyor

the Ornamental Iron Works of the Canadian Allis Chalmers, Toronto, and it is certainly an unusual but very pleasing addition to a power plant. In most cases the need of such a stair would have been filled by a useful, but not ornamental, straight iron ladder. The existing stairway is far easier to climb, and much more attractive to the eye. It leads to the roof, from whence access is obtained to the top flight of the conveyor. The photographer, who had to carry a heavy tripod camera up there to obtain the photograph, also gave his unqualified approval to the spiral stair. both from a physical and aesthetic point of view.

The heater is a Cochrane open heater, supplied by the Allis Chalmers Co., and having a capacity of 60,000 lbs. per hour. It is fitted with a V notch meter for measuring the water passing through it, and this meter can be seen on top of the heater on the right. The tank on the pipe up at the top of the wall is an air eliminating tank, for the returns from the vacuum pump, before they go to the heater. The suction pipe to the feed pumps can be seen at the front, and the exhaust pipe and oil separator entering the heater on the left hand side are also plainly shown. The back pressure valve and atmospheric pipe are seen on the left hand side. In the main pump room there are two feed and two vacuum pumps. The feed pumps are respectively a Worthington 12 x 7 x 12, and a Wheeler 10 x 6 x 12 inches. The vacuum pumps, in connection with the Webster heating system, are 10 x 14 x 16, and 12 x 18 x 20 inches respectively. On the wall behind the pumps can be seen the gauges in connection with the vacuum system, and the connection from the main steam to the heating main through a Foster reducing valve. The by-pass is seen right above the reducing valve. The fire pump room which opens off the main pump room at the south end, contains a centrifugal and reciprocating pump. The centrifugal pump is a Worthington direct connected to a C. G. E. induction motor, and having a capacity of 1,000 gallons per minute against a head of 100 lbs., at 1,440 r.p.m. The reciprocating pump is a Buffalo steam pump, Underwriter pattern, having a capacity of 750 gallons per minute. It is 16 x 9 x 12 inches. This fire pump room does not extend the whole width of the pump room, the remaining space being used for wash room and locker purposes.

The Basement

A corner of the basement is shown in the illustration, the opening at the left being the tunnel in which the steam pipes, etc. going to the factory are carried. On the corner of the wall, on a shelf, can be seen one of the Republic flow meters, of which there are four, connected to various departments to measure their steam consumption. The indicating dials are in the engine room. The steam and exhaust heating mains can be seen on the roof of the ceiling, and the return traps draining these members are seen on the wall. To prove that this is a picture taken under ordinary working conditions there is a little trail of dampness on the floor from some small leak, perhaps.

In the basement, though not shown in the illustration, there is a small centrifugal pump, motor driven, which is used for pumping the water from the water softeners to a soft water storage tank, which is contained in the pump room. One of the principal requirements of this industry is a large supply of pure water, and in order to obtain this, both Refinite and Permutit systems have been installed.

The Engine Room

The engine room is a large square room, filled with light, clean as a new pin, and altogether, about as pleasant a place as an engineer could look for in which to pass his working hours. The walls are all finished in white and glazed enamelled brick, and the floor is tiled. The height can be seen both from the inside and outside views we show, and a very interesting feature is the lighting arrangement, consisting of a regular street lamp fixture, with four arms, and four lamps. This fixture is practically in the centre of the engine room, and although we have not seen it at night, we can well understand that it will prove a very efficient arrangement, especially with the backing of those white walls.

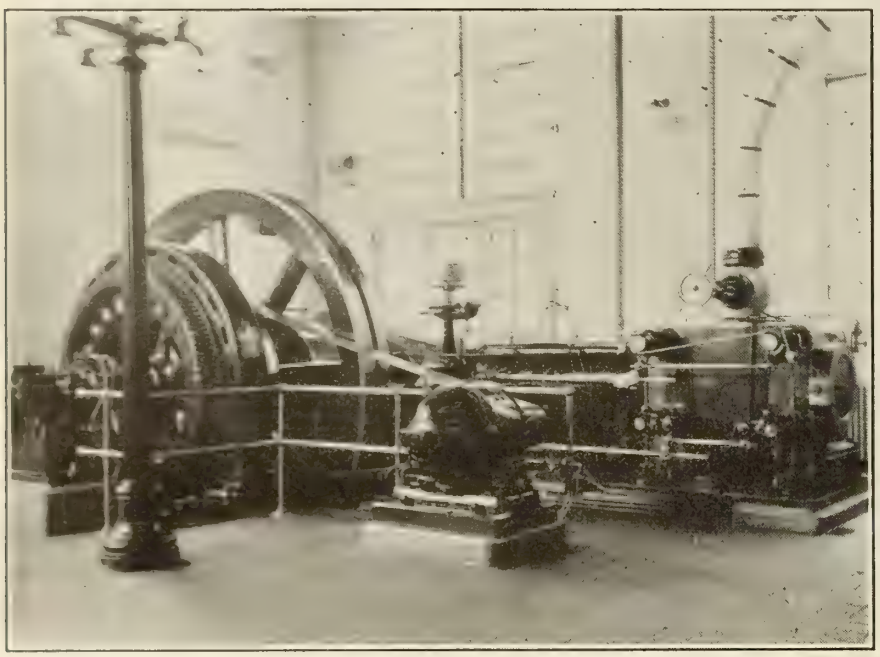
The engine is a Goldie and McCulloch heavy duty Corliss, single cylinder, noncondensing, with a cylinder 22 inches diameter and 36 inch stroke, and 125 lbs. working pressure.

It is direct conected to a Canadian General Electric alternator, developing 375 K.V.A. at 550 volts, and 25 cycles. The exciting unit is driven by belt from the engine by means of a pulley.

The switchboard contains eight panels, and these are divided into receiving and distributing panels for both the

engine and the hydro power. There are four power distributing panels, and two lighting panels, the other two being the receiving panels. The board contains in addition to the instruments for ordinary operation, a recording wattmeter, graphic meter, integrating and recording K. W. meter, and automatic voltage regulator.

The power from engine and hydro is regulated in such a manner that the engine takes all peak leads, thus keeping the hydro demand down to a steady figure, which averages about 600 h.p. The exhaust from the engine is used to supply hot water to the dye house in the summer, and in the winter, in addition to this duty, there is the heating of the buildings to look after. The feed is also heated by exhaust from the engine through the Cochrane heater.



Goldie and McCulloch Corliss direct connected to G. E. alternator 375 K.V.A. 550 volts, 25 cycles

On the engine room wall between the doors leading to the heater platform and pump room, is set the gauge board, oil filter for the engine lubricating oil, and the indicating dials in connection with the Republic flow meters in the basement. The gauge board is a marble panel, matching the switchboard panels, and contains six gauges. These are at the top, a recording thermometer showing feed heater temperature, which averages about 210 degrees. The next two below it are the low and high pressure steam recording gauges, the low pressure on the left and the high on the right. The next lower gauge is the stack temperature recording gauge, which reads 450 degrees. The pair below that are, respectively, on the left the vacuum gauge in connection with the heating system, showing 10 inches, and the city water pressure gauge.

The dials of the flow meters are arranged so that they can be switched to any of four departments taking steam. There are four separate departments from which records are required, and each dial is connected to two instruments, so that by throwing a switch, either of the two instruments with which it is connected will register. The engine carries about 250 h.p. in summer, and in winter, when the lighting load is on, the horse power is about 450.

The Power Staff

We were fortunate in being able to get a group photograph of the staff which operates this plant. Seated in the chairs in the front of the group are the chief engineer, Mr. W. Clark, and the chief electrician Mr. Farrar. Mr. W. Clark, is sitting on the right hand side, with Mr. Farrar, the chief electrician on Mr. Clark's right, or the reader's left.

The group behind, reading from left to right, are Messrs. Lloyd, fireman; Griffiths, assistant engineer, Ransome, repair man; J. Goold, fireman, (who by the way has the Military Medal, won in the Great War); Sellers, and Strain.

The plant is kept in apple pie order, not only in the places which are exposed to the view, but in the corners and basement also. Brass work is shining, and floors are spotless, while the boiler room is remarkably free from dust. The only trace of anything looking like a leak that we saw was that shown in the photo of the basement, and the source of that was not visible. We do not say that there was not a leak in the plant, but there were certainly none that assailed the ear or eye, and we have a pretty keen eye for those kind of things.

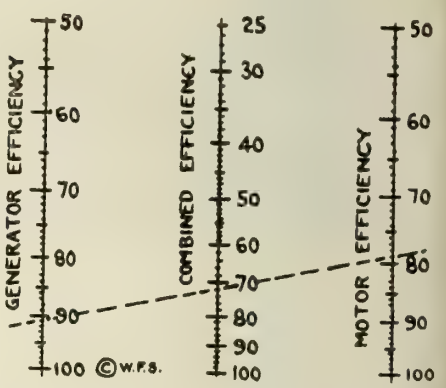
The plant is one of the most interesting in the city, the engine room in particular being one that pleases the eye with its large expanse, and broad high windows. When we think of some of the glory holes we have seen engine and boiler rooms crowded into, we can understand why the staff wear the contented looks shown in the picture.

What is the Combined Efficiency?

By W. F. Schaphorst

In the electrical transmission of power we always have at least two efficiencies to consider—the efficiency of the generator and the efficiency of the motor. Where the distance between generator and motor is great the line efficiency also must be considered, but in most factories and shops using electric power distribution the line efficiency is so nearly 100 per cent. that it can be neglected. I have therefore neglected line efficiency on this little chart.

For example, if the efficiency of the generator is 91 per cent., and motor 79 per cent., the dotted line drawn across this chart shows the combined efficiency to be 72 per cent. The chart will figure



any combination where the efficiency of either generator or motor is over 50 per cent.

One of the much mooted questions is: which is best—electric or belt transmission? The answer is: "It all depends on conditions." The object of this chart, therefore, is to help you answer the question for yourself. With ball bearings and low belt tensions the efficiency of belts and shafts may reach a very high figure—95 per cent. and over. That is a point that must be taken up with the manufacturer. But if it is made certain belt transmission will provide even 80 per cent. efficiency that, in most cases, would eliminate the electric drive, although, of course, efficiency is not the only thing to be considered.

To assist users of the chart I give these average efficiencies of generators and motors at full load: Direct current generators—50 Kw, 90 per cent.; 100 Kw, 91 per cent:; 1,000 Kw, 93 per cent—Motors, ¾ h. p., 64 per cent.; 5 h. p. 80 per cent.; 15 h. p., 84 per cent.; 30 h. p., 90 per cent., 150 h. p., 92 per cent.

Alternating current generators: 50 Kva. 90 per cent.; 100 Kva, 91.5 per cent.; 500 Kva, 94.5 per cent.; 1,000 Kva, and over 95 per cent.—Motors, 1 h. p., 76 per cent.; 10 h. p., 85 per cent.; 100 h. p., 90 per cent.; 200 h. p., 92 per cent.

Economisers and Economiser Operation

Status of the Economiser in American Practice—Where An Economiser Installation is Indicated—Progress in Structural Details—Modifications in Soot Cleaning Arrangements—Notes on the Operating Features

By FRANK H. PROUTY

THE first ecomomiser installation dates back more than 100 years; every year has seen an increase in the number of installations, yet it may be said that (in the United States) the economiser is still in a period of trial and transition, and has never been fully accepted by the American engineering profession.

Old Installations Often Inefficient

Certainly there are a number of economisers throughout the country which positively detract from the overall efficiency, and which it would be cheaper to remove or permanently bypass than maintain in operation. Such results may come from insufficient stack draught, improper proportioning of economiser heating surface to boiler heating surface, feed-water temperature under 100 degs. F.—causing extreme external corrosion and excessive soot caking,—feed-water temperature over 200 deg. F., which may be too close to the breeching temperature for sufficient heat transfer, or the not uncommon failure due to neglect in operation. On the other hand, there are economiser installations which will meet the manufacturers' entire claims, and which are indispensable to high efficiency. Such results are obtained when there is 350 deg. F. difference between entering feed-water temperature and breeching temperature, an induced-draught fan to provide ample draught, a proper relation between boiler heating surface and economiser heating surface, a counter-flow relation between water and gases, and a clean economiser.

Theoretical Need of Economisers

The theoretical need of economisers becomes apparent, for if heat is to be imparted to the boiler throughout the travel of gases over the tubes, the gases must manifestly leave the tubes at an appreciably higher temperature than the steam and water within. If the steam temperature is 375 deg. F. and the gases have an excess temperature of 125 deg., then the resulting stack temperature of 500 deg. may represent a loss of 15 per cent. of the total heat available. A counter-flow type of economiser placed between the feed-pump and the boiler and in this flow of gases will most effectively reduce the gas temperature, the water having a high boiling point, due to its pressure and high heat absorption, because by flowing in a direction opposite to the flow of gases there is always a maximum temperature difference between the two. That counter-flow principle also minimises temperature strains, and with cast-iron tubes and headers this item rises to prominence.

The lower the temperature of the feed-water entering the economiser, the lower will be the final gas temperature, yet the former should never be below 100 deg. F., and preferably well above this figure, because low feed-water temperatures cause moisture in the flue gases to condense on the tubes and headers, and this moisture, combining with the sulphur usually present in the gases, forms sulphuric acid, and rapid corrosion invariably results.

Economisers as Purifiers

Economisers in a limited manner act as purifiers, causing the deposit part of the solid matter held in suspension and precipitating out a large portion of the carbonates held in solution. Most scale is formed by the carbonates and sulphates of magnesium and calcium, the carbonates resulting in temporary hardness and the sulphates in permanent hardness. As only the carbonates are precipitated out in an economiser, it may be said that its purifying action deserves small consideration, it doing little more than relieving the boiler blow-off of carrying away a portion of sludge.

Progress Made in Steel-tube Economisers

Economisers in this country (U.S.) have generally been made cast iron, and because of the tensile weakness of cast iron for high feed-water pressure, numerous attempts have been and are still being made to perfect a steel-tube economiser. Steel-tube economisers have proved unsuccessful in the past because of excessive internal corrosion due to air held in solution with the feed-water. Attempts to galvanize and otherwise coats the inside of steel tubes failed to prevent corrosion. However, recent experiments have shown that the air in feed-water may be greatly reduced by maintaining a heater temperature near the boiling point, by filtering, or by forcing preliminary oxidation by passing the feed-water over iron filings placed in the heater outlet. An improved method now being commercialized is to boil the water under a partial vacuum. This method not only gives an increased extraction of air, but has the additional advantage of treating water with a temperature well under the atmospheric boiling point. This latter point particularly benefits where the temperature of gases flowing through the economiser requires that for maximum heat extraction the feed-water temperature be down around 150 deg. F. A number of steel-tube economisers are now under trial, and with the present development of de-aeration some installations will undoubtedly prove successful. Cast-iron economisers are also subject to internal corrosion, but so moderately that in very few cases has internal corrosion caused failure.

Replacing Mechanical Scrapers by Soot Blowers

Economiser tubes collect an external deposit which requires constant removal and some economisers are equipped with mechanical scrapers for removing this deposit. There is a considerable amount of mechanism to these scrapers, and in recent years a strong movement has been made to replace them by soot blowers. Soot blowers require less exposure of the attendant to the excessive radiant heat of the economiser, they can keep the economiser tubes cleaner, have a lower initial cost, and can be operated and maintained at a considerably less cost than can mechanical scrapers. However, mechanical scrapers will successfully do their work, and they have advantages in that they deposit the scrapings into the hopper underneath the economiser, while the soot blower blows most of the cleanings out of the stack, and the scrapers operate dry, while the soot blowers deposit a certain amount of moisture on the tubes. The latter advantage is of small importance where the water entering the economiser is close to 200 deg. F.; and where superheated steam is used to blow, the use of soot blowers may cause rapid and disastrous corrosion of the economiser. Some manufacturers equip their economisers with soot blowers, while in other instances scrapers have been replaced by soot blowers after the original installation.

Induced-draught Fan Necessary

It may be said, almost without exception, that good results will not be obtained from an economiser unless it is used in conjunction with an induced-draught fan. The loss of draught gas due to gases cooled to around 350 deg. F., together with the additional resistance necessary to pull the gases through the economiser, would require a stack prohibitive in size to carry peak loads or run high ratings.

The commonly used induced-draught fan and short stack result in the emission of large quantities of dust, the

controlling of which gives rise to a problem of considerable magnitude. This dust has been successfully controlled by an induced-draught fan, which also embodies a centrifugal dust-catcher, the dust being driven by centrifugal force to the outside periphery of the fan, where it is deposited and collected. This method removes but a portion of the total dust, and the upkeep cost is largely due to the abrasive action of the particles. Another method is to wash the dust out of the gases by passing them through washers. This method is expensive to install, and a loss occurs in stack draught due to a cooling of the gases. The cheapest and simplest remedy seems to be that of attaching a collecting hopper to the boiler breeching, and baffling the gases down against a series of louvre blades placed in the top of the hopper. These blades snub the dust particles and cause them to drop into the hopper below. As this dust often contains from 60 to 65 per cent. fixed carbon it is possible to burn it in a Coxe stoker.

Economiser Operation

Cast-iron economiser tubes are usually cleaned with water-driven turbines, the water acting as a cushion and preventing the turbine from smashing the tubes. However, an air-driven turbine can be used with equal success if equipped with a limit ring. After cleaning economisers several times it is often difficult to prevent the caps from leaking. In such cases hot joint paste is superior to pastes of lead or shellac.

When economisers are newly installed it is not unusual to experience a considerable breakage of headers. The cause may be initial strains in sections set up when section is assembled at factory, pressure shock in feed-water lines, temperature shock due to cold air coming up through openings in hopper under economiser, or by expansion strains due to local conditions. When a factory-assembled header breaks and it is replaced by a hand-assembled header, the latter seldom breaks. In order to avoid pressure shocks, every economiser installation should have an air chamber in the feed line. This chamber may consist simply of a dead-end pipe connected to the feed-line and carried well up above the economiser.

Manufacturers of economisers once advised by-pass flues for by-passing the gases around the economiser when repairs are being made. It has been found that generally there is not enough use for a by-pass to warrant its existence, and when once installed a by-pass is a constant annoyance, due to leaks and damper disarrangement. If the induced-draught fans are to be worked by automatic control, it is advisable to place a damper in the economiser breeching. This damper, if properly tied in with the fan, will assist the fan in finding its proper draught balance.

Economisers Not Always Installed in Modern Plants

As previously stated, economisers have never been fully accepted by the American engineering profession, and many modern plants are being built with economisers permanently omitted. However, most of these plants, instead of truly eliminating the economiser, have really made it an integral part of the boiler itself. The most common method employed when economisers are omitted on horizontal-tube boilers is to build the boiler several rows of tubes higher than standard, and this additional heating surface really amounts to an integral steel-tube economiser. With vertical-tube boilers the additional tubes are added to the rear tubes of the boiler. One advantage of this method is that the increased resistance to gas flow is so small that an induced-draught fan is not required, and by insulating the breeching and lining the stack it is possible to run high ratings on stack draught without induced draught fans. Of course, it is always possible to get lower final stack temperatures by using an economiser, and hence higher overall efficiency, but it is a much mooted question whether the net financial gain will always favour the installation of economisers. If it is decided to install economisers in a modern boiler-house, a heat balance should be worked up very carefully to determine whether auxiliaries shall be steam or motor driven. It is usually necessary to motor drive some of the auxiliaries in order to avoid an excess of exhaust steam in the heater such as would raise the feed-water temperature above the most economical temperature for economiser operation.—"The Blast Furnace and Steel Plant," Pittsburgh, U. S. A.

HEATING AND VENTILATING ENGINEERS

A Canadian Chapter has been formed of the American Association of Heating and Ventilating Engineers, to be known as the "Canadian Division, Ontario Chapter," with a membership of about 35. The first meeting was held on June 2nd and the following officers appointed:

M. F. Thomas, president; H. H. Angus, vice-president; A. S. Leitch, secretary; A. J. Dickey, treasurer.

Monthly meetings will be held in Toronto.

OXYGEN PRODUCERS CONSOLIDATE

The consolidation recently of the manufacturing and distributing resources of the Dominion Oxygen Company, Limited, and the National Electro Products, Limited, gives to Canada one of the largest organizations of its kind on the continent. The business is henceforth to be conducted under the name of the Dominion Oxygen Company, Limited, now operating oxygen plants at Montreal and Toronto, and acetylene plants at Merriton, Winnipeg and Shawinigan Falls. In addition the company conducts oxygen and acetylene distributing stations at Hamilton, Windsor and Quebec. It is claimed that the union of the two companies will be of material advantage to all Canadian oxygen users through stabilization of the product, assurance of steady supply and certain improvements in service that enlarged facilities will make possible. It is understood that Mr. W. J. Cluff and associates, of Toronto and Montreal, who founded the National Electro Products, Limited, several years ago, will retain their relationship with the oxygen industry through their interest in the consolidated companies.

U. S. BUREAU OF MINES

O. P. Hood, chief mechanical engineer of the Bureau of Mines, sailed on July 12 for London. Mr. Hood will spend three months in Europe studying new developments in lignite utilization and the low temperature carbonization of coal, for the purpose of applying the information to studies in lignite and fuel utilization now being conducted under his direction in the United States by the Bureau of Mines. Mr. Hood will visit England, Germany, Switzerland, Belgium, Holland, Jugo-Slavia, Czecho-Slovakia, Austria, Italy and France.

FIGHTING FOR A CONTRACT

In the consideration of tenders for a four million gallon centrifugal pump for the Toronto Island pumping station, Commissioner Harris, before Toronto Board of Control, was disinclined to award the contract to the John Inglis Co., Toronto, claiming that they were not equipped. He seemed to have lost sight of the fact that the Inglis people have installed pumps to the capacity of two hundred millions of gallons in Toronto services. They have put in a tender of $10,791, which, after some show of a fight in the Board, was accepted. The Toronto plants having Inglis equipment are the main station, twenty million gallons, electrically driven; filtration plant, seventy-five million gallons, steam; sewage plant, twenty, seven, and one and one-half million gallons, electric; main station, fifteen million gallons. Corliss steam; high level, six million gallons, Corliss steam; filtration plant, two million gallons, duplex steam.

"It's pretty tough when a Toronto man can't get a job in his own city," Mr. Inglis told the Board.

"The other pump is a better pump, that's all," remarked Commissioner Harris.

"That makes it a serious matter when the Toronto firm says it will build a pump according to your specifications and with a guarantee," said the mayor.

"What's the use of calling for tenders?" asked another controller, who moved that the local firm get the contract. The motion was carried four to one.

Autobiography of a Sixty-Four-Year-Old Engine

Born in 1858, Nine Years Before Birth of Dominion—Product of Dumfries Foundry—Cylinders Rebored Only Once in That Time —Still Going Strong With Chas. Barber & Sons, Meaford— Vertical Slide Valve Type—Has Passed Through Stirring Times

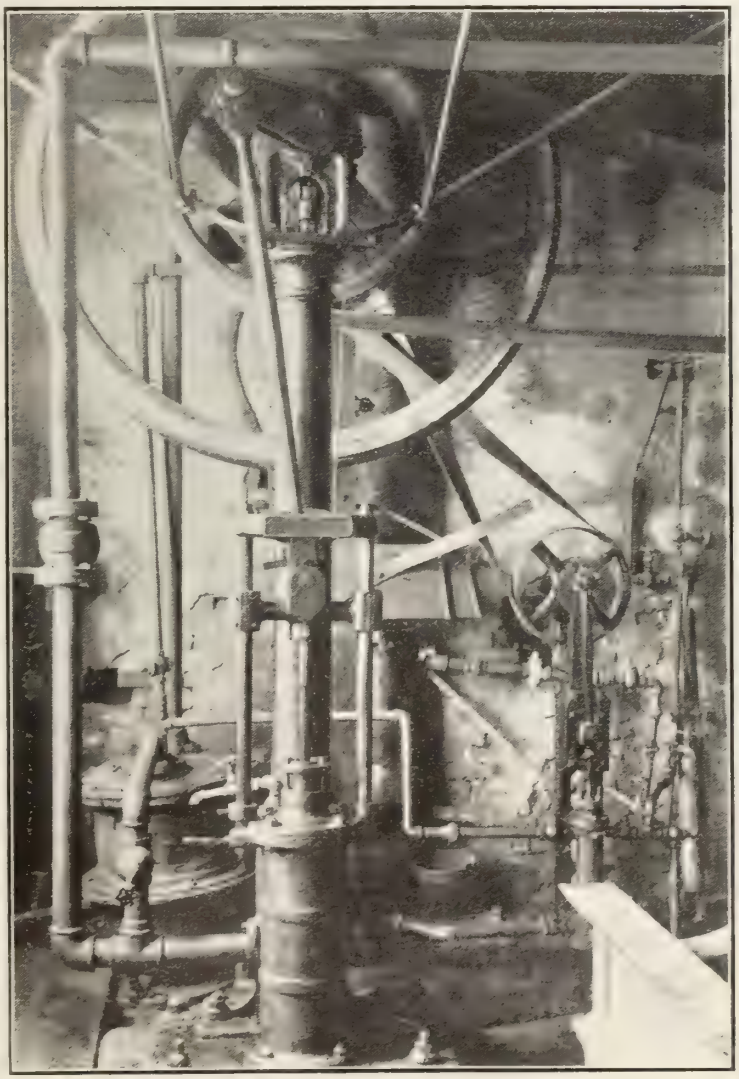
IT HAS often occurred to me that in any autobiography that I might be guilty of, it would be a difficult matter to establish certain matters pertaining to my birth. It seems reasonable to say that certain of the materials entering into my composition were originally in the shape of iron pigs, the ore from which came from a place I have often heard referred to as "the other side." Perhaps they brought my steel from the same place, but the fact that I wish to remember is that the castings, the pistons, the driving rods, and all that were turned out and assembled by the men of the Dumfries Foundry Co., in Galt in 1858. I understand that the firm has since changed its name to the Goldie & McCulloch Co.

It seems absurd that a steam engine such as I am should claim to be a member of any particular sex. If I were a female person, does it not seem ridiculous that I should boast about my 64 years of age? Moreover, in that time I have heard so many names applied to me that I confess I am a bit confused. I recall that, when they had me crated and ready for shipment, one of the men came up to me with a brush and pot of glue and asked some person where "this bird" was going. The reply was that I was going to a village called Leith, near Meaford, and that it was a mighty good place to go. Let me whisper that my first job at turning the wheels of industry was in a brewery. But they fed me on steam from water, and, in spite of my surroundings, I never missed a stroke. Well, an engine must age quickly, in appearance, for I hadn't been on the job very long before the engineer referred to me as an "old girl." I took this in good part, but imagine my consternation when one day about 10 years ago a party of men looked me over and one of them referred to me as "some baby," while it wasn't so long after, that some youth with no germ of reverence in his soul, called me an "old coffee grinder." I think it was the boss who replied that "if you have done your work as well as she has by the time you are 60 years of age, you will not have to view the future with alarm." I thought that was rather fine, and I certainly delivered the goods that day, but there again he seemed to classify me as feminine.

So I have concluded that the sex of the steam engine, like that of a mud turtle or a concrete mixer, is largely a figure of speech. I just wanted to say that I have been wedded to work all of my life, that I feel fit as a fiddle yet, and if I couldn't do a good day's work I wouldn't want to be here.

To return to the story. A few years later, something happened and I was moved to the machine shop of Chas. Barber at Meaford. Call it the irony of fate, or just engine luck, whatever you like, but to come from a brewery to a place where they were making water turbines seemed quite a radical change. However, I had always been noted for my sobriety, and I understand that at the present time the national drink is water and quite a few places that once were breweries are specializing in what are known as kickless libations. I have often wondered how an engine would behave if given a shot or two of "double distilled damnation." I overheard a man remark once that he had had a few shots and felt all "gummed up;" so I supposed that would be my experience. Nothing, not even a human being, can do a good day's work as a regular thing, on gummed cylinders. Believe me or not, just as you like, but I should know what I am talking about when I say that in all my 64 years' experience. I have only had my cylinders rebored once, and that is the only time I was ever shut down for any length of time. That, I should say, is a record. I suppose there are those who will say that had I been fed on alcoholic substance, my cylinders would have given out long ago. All I have to say is, it depends on the cylinders.

During my lifetime, a lot has happened to Canada. I had just taken on my first job at a time when there was some kind of row between Upper and Lower Canada over representation by population. In those days Upper Can-



Steam engine built by Dumfries Foundry Co., Galt, sixty-four years ago. Still in operation in plant of Chas. Barber & Sons, Meaford.

ada had about one million and a quarter of population while lower Canada or Quebec had about one million. Galt, I may say had about 5,000.

Things at that time were shaping towards Confederation and I was some engine on that 1st of July, 1867, our first Dominion Day. I remember the American Civil War, which Canadians helped to win, and also that first of June in 1866 when the Fenians crossed over at Black Rock near Buffalo and threatened to clean up Canada. However, I still plugged away, and was pleased to learn shortly afterwards that the Fenians had returned home, not without losses, and that these unfriendly acts were stopped.

Among other events of an unpleasant nature that have occurred in my day was the Red River rebellion in 1869, when Louis Riel, and some French and half-breeds on the Red River, resented the action of the government in taking over the Northwest. This trouble was crushed, and the country settled down to business. I want you to know that I was shaking a pretty mean piston when Winnipeg, then Fort Garry, was in the making. I was in fine shape during the building of the Intercolonial and the Canadian Pacific railways, and have passed through all kinds of those political crises which seem necessary in the building of a young country, and it is some source of satisfaction that the country and I have come through it unscathed and still have a future. I think it was during a political campaign that I was bored for the second time in my existence.

The Northwest rebellion came along in 1885, and was short-lived, as was also Louis Riel, once they nabbed him. Then, fourteen years later, occurred the South African war, and Meaford sent some of her boys in the first contingent to aid the Motherland. Maybe I didn't regret that I was only a steam engine in those days, but I did the next best thing and kicked out a good day's work at home. Then, in 1901, the whole country mourned the death of Queen Victoria. It was not long after this that the Duke of Cornwall and York visited Canada.

You must remember that during all of these years, Canada has been growing by leaps and bounds, not only in population, but in development of resources. When I was but a kid, they still illuminated the streets with coal oil lamps, and the houses to. Horses were used for Toronto street cars. If a person wanted to go anywhere he probably went on horseback. It took three or four hours to drive over to Owen Sound, and here I want to say that I hope I'll live to see the day when there will be some kind of railroad running over to that town. To drive that distance in winter time is no joke. Well, now we have gas and electricity and these have brought about great changes in methods of doing things. To add to the pep of the times, along came the motor car, and the internal combustion engine and aeroplanes, all that sort of thing. Speed and increased production have supplanted the methods of saddle days. I want to claim a certain amount of credit, for I have had some share in it all, having helped turn out equipment used to generate electricity. Interesting, is it not, to think that an engine of my age should be identified actively in a modern engineering plant?

The most tremendous event of my career was the world war. This was a gigantic struggle, and early in the game I could see that it was going to demand the best in all of us. We were pushed to the limit, but again came through victorious. The fact I want to press home here is that a lot of things, some big and some little, some good and some bad, can happen in the course of sixty-four years, but if you are made of the right stuff, stick to business and measure up to its demands, you are bound to come through. Take it from one who knows more about revolutions than Ireland or Mexico put together, the man or engine who minds his own business, and does it well, won't have time to get into trouble.

There goes the whistle, and I guess they'll choke me off for the night. Take a look at my picture. I'm of the vertical, slide valve type, and differ somewhat from my more graceful, modern brothers or sisters. But though I may be odd looking, I know something about "the amplitude of time," and don't owe anybody anything.

NOTES ON SPONTANEOUS COMBUSTION

Although coal may be a wee bit difficult to obtain and store at the present moment, the Bureau of Mines evidently is of the opinion that some day the black diamonds will again be tumbling merrily into hopper and bin, from a statement just made by O. P. Hood, chief mechanical engineer, on the storage of coal and the attendant problem of spontaneous heating. In storing coal, the risk per ton of spontaneous combustion is really very small, says Mr. Hood. If one counted the times a portion of coal was stored where it would be undisturbed for a few weeks, the number of storage operations in any one year would mount into the millions. Of these, a relatively small number show the phenomena of spontaneous combustion. It is extremely rare that in the smaller operations involving only a few tons there is any heating. There is spontaneous combustion of anthracite, and very rarely does the domestic consumer of bituminous coal find troublesome heating. The main interest in the subject lies in the large piles needed as reserves for public-service utilities and the industries.

Everyone desires to have directions for storage that are perfectly simple and yet will insure against loss. Unfortunately, the problem is too complicated for a simple solution. Many of the factors involved are difficult to determine, as there are no practical means of quantitative measurement. The factors involve chemistry, physics, and engineering, and the man who is in close contact with the problem of stored coal is not always a good observer in these several lines. The result is many incorrect theories, opinions, and prejudices. Much has been written on the subject, and the Bureau of Mines has published the results of extensive investigations, but the diversity of widely held opinions shows that there is need of pointing out what are the factors that demonstrably are most concerned in the spontaneous heating of coal.

Acre of Exposed Surface in Ton of Fine Coal

The heating of coal is believed to be a surface phenomenon. If a ton of bituminous coal could be delivered in a single cube, each dimension of the cube would be about 2.8 feet. When coal heats, it is due to something that goes on with respect to the surface and not something that happens inside of the piece. So far as is known, this is true no matter how finely the piece is divided. It is, therefore, interesting to know the area of the total exposed surface in a ton of coal. If the cube, having originally an area of about 47 square feet, be continuously subdivided until all the pieces are fine enough just to pass through a 16-mesh screen the area of exposed surface in one ton of coal becomes an acre. It is perfectly obvious from this why it is that trouble from spontaneous combustion originates in fine coal, because the great increase in extent of surface does not begin until one gets below 1¼ inch, or nut size. If fine coal is kept out of the pile the heating surface is relatively so small as to remove the cause of spontaneous combustion. This remark applies not to the fact that one may buy lump coal but to the size of what actually gets into the storage pile. Coal bought as lump at the mine and handled with modern disregard for breakage may be far from lump coal when in the pile.

A unit of area of this coal surface generates a certain amount of heat, provided the coal can find the combining material, that is, oxygen. The amount of heat generated depends upon the temperature of a piece of coal. That is to say, coal put into storage at a temperature of 80° F. will generate very much more heat per unit of surface than if put into storage at the temperature of 60° F. It has already been a matter of observation that coal stored during the hot months of summer and in heated regions is much more liable to spontaneous combustion than coal stored in colder climes and in cooler seasons of the year.

Another most important factor is the freshness of the broken coal surface. For the first few days or weeks the freshly broken coal surface is very much more active in the taking up of oxygen and consequent production of heat than after a few weeks or months—a fact that must be borne in mind when considering the wisdom of crushing coal immediately before storing it. Spontaneous fires rarely occur after the coal surfaces have been exposed for three

months. As the rate of heating increases with the temperature, it is evident that if the heat generated is not removed, the process becomes a self-aggravating one, and the rate of heat generation, instead of falling, may rise with time. If the temperature of the pile reaches 140° or 150° F. and continues to rise, there is a high possibility that within a few weeks a destructive temperature will be reached. If the temperature reaches 160° or 180° F., there is almost certainty that a destructive temperature will be reached and that the coal must be moved. Immediately the question of getting rid of the heat is presented.

A Pile of Coal "Breathes"

A coal pile is cooled by radiation and by the movement of air through it. Air moves rather freely through a pile of coal, and in many piles of coal this natural change, or breathing, of air is enough to carry away the heat generated. Some observers have stated that, in general, fires in large coal piles are found in the regions from 5 to 8 feet below the surface on the flanks of the pile. The rise in temperature of a coal pile is thus intimately connected with a very complicated ventilating problem, and there are no means of observing or measuring these small and wayward ventilating currents. Since there are no means of knowing just what the ventilation is in any given portion of a pile, there is greater hesitancy in advocating ventilating schemes for coal piles, as one is as likely to make trouble as to prevent it, unless extreme and uniform ventilation is assured.

There are many more factors of minor importance, continues Mr. Hood. One of the troubles has been that undue attention has often been given to the minor factors, such as the sulphur or the volatile-matter content of the coal, height of pile, etc., while the main factors, such as initial temperature, breakage in handling, freshness of the coal, and the screening before storage, have been overlooked or minimized.

Various factors in the spontaneous combustion of coal are discussed by Mr. Hood in Technical Paper 311, issued by the Bureau of Mines.

JAPANESE RAILWAY ELECTRIFICATION

A comprehensive plan has been adopted for the electrification of the Japanese Government railroads and a special bureau has been established to carry out the work. The first sections to be electrified will be the Tokaido line, 408 miles, from Tokyo to Kobe, and a portion of the central line between Tokyo and Kofu. It is proposed to supply power from a hydroelectric plant on the Shinano River. Electrification of the seven-mile section now in operation over Usui Pass, between Tokyo and Nagano, has been highly successful, according to Commerce Monthly.

Some of the Factors Entering Into Power Costs

THE manufacturer's cost of power in many cases only amounts to the equivalent of petty cash, and has therefore during prosperous times received very little consideration. However, due to competition, the manufacturer to-day is watching very carefully the items of his petty cash and should in turn take a greater interest in his electric power bill and understand something of the factors which enter into its makeup.

A Canadian manufacturer's bill, generally speaking, is based on one of two methods. 1. A charge of so many cents per kilowatt hours only. 2. A charge per h. p. of demand, plus a charge per kilowatt hour.

Ten years ago, practically the only method in Canada was No. 1, but the power companies came to realize that there was a difference between the customer who used 24 kilowatt hours in one hour and the customer who used 24 kilowatt hours spread over 24 hours. The difference being that the first customer used 24 times the amount of machinery as was required for the second class of customer and in turn the fixed charges would be 24 times as much in the one case as in the other. An illustration with which we are all familiar is the summer hotel. Their rates are always high in view of the service they actually give because they have to pay all the interest charges in a matter of one or two months, instead of spreading it over the whole twelve months as is the case with any hotel in the city.

Now let us consider for a moment what fixed charges represent to a distributor of power. These charges naturally cover the interest on investment on the building of the power station, the construction of canals or reservoirs, the installation of water wheels and generators or steam engines and generators, the building of transmission lines, transformers, etc.

It is an interesting fact that the interest on the building of a water power plant, including the items shown above, represents approximately 85 per cent. of the total cost of supplying the power; in the case of steam, approximately 45 per cent. of supplying the power.

Thus it is readily understood that if one customer requires 24 times the amount of fixed charges for the same number of kilowatt hours, his bill should be greater than the second class of customer mentioned.

The result of the realization by the suppliers of power, of the importance of this factor, led to the second method of charging, i. e. h.p. of demand plus kilowatt hours used. The only real difficulty was there was no instrument at a reasonable price available for the measuring of this factor. Therefore except on large customers (where valuable instruments were economically possible) the total h.p. of the machinery installed was adopted as the basis upon which to determine the h.p. of demand and this system which is fairly well known i. e. the "installed capacity" became quite general.

This system however, was not ideal for the folowing reasons. Some manufacturers will put in motors larger than necessary in order to provide for the future. Others have grown so rapidly that they have motors very considerably overloaded. The installed capacity basis penalizes the first class of manufacturer and gives the second class of manufacturer something for nothing.

Another difficulty is that the driving of individual machines is now considered the best practice from an engineering point of view, but if all the individual motors are totalled up, the installed capacity is quite high compared to the actual amount of power taken at any one time. Thus although the manufacturer is adopting the best practice he will again be paying for more than he uses. Also the manufacturer would pay just the same, as far as the demand portion of this bill was concerned, whether he was busy or slack. Whether he had motors running or idle.

As a result of these conditions a very definite demand was created for instruments at a fair price which would measure the demand portion of a bill. Such instruments have been on the market for some considerable time and are coming into very general use and it may be of interest to give some of the characteristics of their operation. Such instruments take the average of the peak for say 10 or 15 minutes and are so arranged that they push a pointer upwards on the scale. If, for instance, the maximum to-day is 10 h.p. averaged over a 10 or 15 minute period, the pointer will read that amount. If next week the average increases for any 10 or 15 minute period to 15 h.p., the pointer will be pushed up and will remain at that point. An illustration of what is meant by the average over a 10 or 15 minute period makes this point quite clear. Your motor car may have reached for a few moments a speed of 35 miles an hour, but the average speed for a period of 15 minutes will be only 20 miles per hour. In electrical terms your motors may pull 35 h.p. for a few seconds, but the average load or demand over a 15 minute period is only 20 h. p. and 20 h.p. is what the bill would be based on for the demand portion.

Refractory as a Factor of Furnace Life

The Capacity of the Furnace for Continuous Operation Under High Ratings Depends Largely on the Quality of the Lining. Modern Tendencies Are Toward the Monolithic Type of Lining

By I. S. PIETERS

IN THE MODERN boiler room the furnace imposes the limitation. How soon the limitation is encountered depends upon how carefully the furnace is designed and the wisdom in the choice of materials comprising it. It is only comparatively recently that the importance of the furnace has been fully appreciated.

It is the furnace that determines the maximum combustion efficiency that can be attained; it decides the economical efficiency that should be maintained. It is the furnace that is usually the first to wear out and so compel a shut down for repairs. It is also the factor that ordinarily determines how "hard" a boiler or a fire can be worked. The more closely boiler room operation is examined the more apparent will it be that the furnace is all-important. A study of conditions immediately shows why this is the case. Further, it explains why of recent years the furnace has come in for the largest amount of attention and the most radical changes.

Perhaps the most prominent tendency during the last few years has been that of operating boilers at higher rates of evaporation. One boiler horsepower is nominally equivalent to 10 sq. ft. of boiler heating surface; when every 10 sq. ft. of heating surface evaporates 34.5 lb. of water per hour, the output is said to be one boiler horsepower. Actually, however, three to five times this amount of water is evaporated for every square foot of heating surface. This means that somewhat more than three to five times the amount of coal must be burned in the furnace to evaporate this larger amount of water. But by working existing equipment many times harder than the nominal, a given investment is made more useful or the money sunk in new apparatus can be reduced. It pays to work apparatus "hard."

Higher combustion rates necessitate radical changes in both the design of the furnace and the materials that go to make it. Larger furnace volumes are required so that the larger quantity of air and gas may mix with that intimacy so necessary for complete combustion. As ignition is largely a matter of time as well as temperature it has become necessary to increase the length of flame travel as well as the space available for mixing air and combustible gases. To accomplish, the height as well as the volume of the furnace has had to be increased.

Because of the larger quantities of coal going into the furnace at these high evaporation rates, the fuel beds are thicker and so offer higher resistance to the flow of air. Higher drafts thus become necessary as well as much larger volumes of air. Mechanical draft is resorted to, therefore, to handle the air and mechanical stokers are used to handle the fuel.

In consequence of these developments the furnace problems that have come about are two-fold. They are those due to higher temperatures on the one hand and those due to mechanical considerations—greater height and greater volume—on the other. Each is closely inter-related to the other. Before discussing the troubles that have come about on account of the higher temperatures and larger furnaces or attempting to explain why they occur or how they may be mitigated and even eliminated altogether for long periods, a thorough understanding of what the furnace walls and interior must accomplish is worth while.

Conditions the Furnace Must Meet

The structure that constitutes the furnace must not only have sufficient strength to support itself at all temperatures that may occur, but it must be capable of supporting whatever loads may be applied to it and whatever stresses may be exerted over the range of temperature that occurs under the most extreme conditions.

Part of the furnace, the inside, must be capable of withstanding for a reasonable length of time the highest temperatures produced in the furnace—namely temperatures between 2,800 and 3,000 deg. F. It must also be capable of standing up under the erosion and attrition of coal, ash and clinker passing along it and adhering to it as well as attack by the fireman's slice bar while he endeavors to break off lumps of clinker and molten ash. The furnace lining must not be chemically active either with the ash and clinker or impurities in the coal (which usually have low fluxing temperatures) otherwise the lining will surely flux and melt. It should have a minimum co-efficient of expansion and contraction and one that remains nearly constant. The material must not be brittle or it will crack on rapid heating; yet it must be tough so as not to be susceptible to abuse. It should not be too porous otherwise it will allow air to flow from the outside to the inside of the furnace; this cool air, of course, lowers the furnace temperature, wastes heat and fuel, may cause damage to the intensely hot boiler heating surfaces, may overtax an already overloaded stack and hasten the spalling of the refractory in the furnace. Lastly, the flow of heat from the inside to the outside should be minimum.

Each of these requirements—refractoriness, physical strength, surface hardness, low expansion and contraction co-efficient, over a wide temperature range, low heat conductivity, imperviousness to air—is of vital importance. These characteristics and requirements differ so widely that no one material can meet them all. Therefore, furnace walls and settings are no longer made up of one material as was once the case but three, four or more materials are used. Each serves an entirely different and distinct purpose; and in this way each material can be chosen specifically for the special condition it must meet.

This, in brief, explains why the furnace of brick or even of two different kinds of brick is rapidly disappearing. It is the reason why the modern furnace with the longest life, lowest upkeep cost and higher thermal efficiency working under the extremely severe conditions of to-day is now invariably composed of three and sometimes four and five different materials.

Typical Furnace Difficulties

Most furnace troubles originate inside the furnace and these, in turn, contribute to, if they do not actually cause those that take place on the outside. Usually the trouble starts at the joints between bricks. Every joint is a weakness and every layer of cement or mortar a possible source of trouble. It is very easy to understand why.

Each brick expands individually according to its individual characteristics and the temperature to which it is subjected. Bricks differ quite widely among themselves in shape, size and ability to stand up under high temperatures; some shrink more than others and some never reach normal size again after heating. Bricks that are not true to size and shape exert a wide thrust against adjacent bricks. Bricks that are too hard are often brittle and crack with sudden temperature changes, on account of internal pressures due to unequal heating or external pressures.

Consequently, the interior surface of the furnace lining when of brick may be smooth and have all bricks flush when first placed into service but it soon assumes a rough and ragged surface to the fire as the individual bricks work about and so retire from and others tend to protrude into the furnace chamber. Those bricks that are most exposed to the intense heat are the first to melt at the corners and edges. As they wear down, other bricks gradually protrude and these too melt so that an endless cycle of deterioration continually goes on.

The cement used to hold the bricks together is a source of trouble in the majority of furnaces using brick. It is an important factor in determining the

strength of a wall as well as the thermal efficiency of the furnace and its life.

The layer of cement must necessarily be very thin—the thinner the better. On cooling after being heated, it usually shrinks and hardens. This weakens the joint, of course and leaves voids of air where the cement was originally. As the bricks move on expanding and contracting, more cement is forced out from between the joints while some of it melts so that the bricks settle down and many of them become loose while others jam. One commonly finds bricks that can be lifted right out of the wall. It can readily be seen why the brick work under these conditions is short-lived when the fireman roughly tries to dislodge adhering clinker from loose and crumbling brickwork. As the bricks disintegrate and the joints between bricks loosen up more and more air tends to enter the furnace from the outside and the greater becomes the waste of fuel from excess air.

Troubles with brick furnaces can be reduced, of course, by using only brick that is true to size and shape and that run uniformly as to material. Further, the cement must be chosen so that it does not act as a flux for the brick and so that it has as close as possible the same co-efficient of expansion and contraction as the bricks it is to hold together. The great difficulty with brick is, however, that bricks in one consignment will vary among themselves. It is difficult to keep sizes uniform; the clay used may come from different locations; the heat treatment may differ so that some of the bricks are more porous, more brittle and of lower strength than others. Bricks in the same consignment may have been collected from different batches that passed through different ovens so that while nominally the same brick they may have quite different characteristics. There are so many opportunities for differences to creep in. And every difference in treatment and manufacture means a possible source of trouble.

At best brickwork is patchwork where not only the brick but the cement that binds them and the men that lay them are variable factors. The periodic cooling and heating to which the bricks are subjected in service soon show the results. As a furnace may require from several hundred to many thousand bricks it is obvious that the opportunity for trouble is very great.

Troubles, frequent repairs, comparatively short life and high upkeep cost are inherent to the brick setting and the only scientific way to overcome them is to employ a one-piece or monolithic furnace lining.

Meeting the Furnace Problem

Since experience as well as theory show that the joints are the weakest parts of the entire brick lining and also the chief cause of trouble, it can be immediately seen that if the joints can be eliminated an immense stride has been taken toward doing away with furnace troubles. The elimination of joints almost entirely is at once probably the most radical step toward longer furnace life and the extension of furnace limitations that has taken place in a long time. This explains why the one-piece or monolithic or jointless lining is proving such a success; and why it is being used especially where furnace conditions are severe, where shut downs for replacements must be minimized and where high upkeep costs have become so serious as to compel combative measures to be adopted.

With the monolithic lining there are no joints. There are no bricks. The lining is a one-piece lining of the same material that after the first heat assumes a smooth, tough surface. There are no protruding parts to be exposed to the heat, to form the nucleus for the building up of clinker masses or to melt down and cause trouble and expense. There are no joints to cause weakness, to serve as channels for cold air to enter the furnace; no bricks to loosen and fall out; no cement to fuse and disappear and no unequal expansion and contraction.

The one-piece, jointless lining is monolithic, of homogeneous material with one co-efficient of expansion. Expansion and contraction occur en masse, without unequal strains and without cracks. There is no chemical action between different substances; it all behaves alike for it is all of the same substance. The lining is chosen for its ability to withstand heat and furnace conditions. It is a refractory used as a refractory where the requirements are for a refractory, so that all the troubles that do occur with the brick are absent.

When a one-piece or jointless furnace lining is used, the rest of the furnace may be built up of materials that insulate, that is keep the heat in the furnace, and have the strength to carry whatever load may be applied. Usually the insulating material is placed next to the refractory or heat-resisting material, next to which is the outside brick, used for its strength and as a support and protection for the insulation and refractory. Quite often the outer brick is covered with an impervious paint which excludes air from seeping through the brick. As the jointless furnace lining seals up the whole inside of the furnace, the entry of air through it is prevented, the increase in combustion efficiency due to this type of lining usually resulting in an increase of from 1 to 3 per cent. in carbon dioxide.

The jointless furnace lining by doing away with all the inherent defects of the brick setting has increased the life of the furnace anywhere up to 500 per cent., reducing the cost of upkeep proportionately. It has enabled boilers to operate for more than a year and sometimes two years without shut down for furnace repairs where with brick, a new lining was required several times a year. It has increased combustion efficiency and so lowered the cost of fuel. It has enabled boiler evaporation to be increased economically far beyond the range formerly possible with economy.

In short, the elimination of joints in the furnace by adopting a highly refractory one-piece lining without any joints, has permitted big economies to be brought about and at the same time has extended the limitations of the furnace enormously.

NEW PUBLICATIONS

We have received from the Taylor Stoker Co. a copy of a new booklet just issued by them, describing the rotary ash discharges as fitted to Taylor furnaces. The book is entitled "The Rotary Ash Discharge," and contains a number of illustrations of actual installa ions in large plants, some of them of outstanding interest, such as the Hell Gate station in New York, and the Connors Creek installation of the Detroit Edison Co. Besides these illustrations which are reproductions of photographs, there are several line drawings showing the details of the installation. The subject is an interesting one, and is well presented.

The Link Belt Co. have issued a bulletin describing their new crawler crane which is essentially a gasoline operated swinging jib crane, mounted on a caterpillar wheel base. It is especially interesting for such purposes as the reclaiming of coal from storage, or unloading and placing in storage. The caterpillars are so dimensioned that the weight of the crane which is 22 tons, is carried with a pressure of only 10 lbs. per square inch on the ground. The lifting capacity is 10 tons at 12 foot radius, and 3 tons at 30 feet radius. The crane can travel ¾ mile per hour, and climb a 20 per cent. grade.

The Link Belt Co. have issued Book 444 describing their Power Hoe (improved drag scraper) for use in reclaiming coal from storage, handling ashes from pile to trucks, or for any purpose where large heaps of small material has to be handled.

Bulletin No. 106 of the C. A. Dunham Co., Toronto, deals with reducing pressure valves, vacuum pump governors, and balanced lever valves. Both outside and sectional views of the different apparatus are shown, and each part is described by means of a reference number and index. Full particulars of the different valves and their application are given in the bulletin.

Canadian Ingersoll Rand have issued a bulletin, Form K-310-A, describing vertical and horizontal air receivers, air aftercoolers, and moisture traps. The aftercoolers are shown in both vertical and horizontal arrangements.

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Sixty-Four Not Out

IN THE GRAND old game of cricket, when a man carries his bat through the entire innings, the record of his score is followed by the words "not out." The engine built by the Dumfries Foundry Co., now Goldie & McCulloch, in the year 1858, is still in the running, and performing useful work for its owners, after sixty-four years of a strenuous life.

There is something to be proud of in the building of a piece of mechanism that can successfully and consistently carry out the duty for which it was designed over a period which exceeds the working life of the man who built it by many years. When the facilities available for building such an engine in the year 1858 are considered, the achievement is all the more creditable. There is of course the fact to be remembered that those days were the days of the real mechanic, who could achieve results with his hands and hand tools, that the average machinist of to-day could not attempt to reach. The machinist must understand how to set up his machine in the proper way, but after that is done, the accuracy or lack of accuracy is a function of the machine, and not of the operator. It is unfortunately true that with the advent of the accurate machine tool, the decline of the mechanic who was proud of his craftmanship began.

The world must move on, and the mass production made possible by machine tools has been of benefit to the community in general, and we would not see the wheels of progress hampered. We cannot help looking with high regard and a certain amount of sentiment on the men who with little else but the hammer and chisel and file, wrought in such fashion that their work remained after they had passed to wherever it is that good mechanics finally reach.

The U. S. Mine Bureau

THERE are some things in which the United States Government shows a good example to the rest of the world, and one of these is in the mater of disseminating specialized information to particular industries and professions. One of the most useful departments is that of the Bureau of Mines, which is continually conducting investigations on the properties of coal, and its efficient application to industry in its various forms. Almost daily bulletins are issued dealing with the results of these researches, and while a large proportion of them have no direct bearing on the problems that Power House readers are interested in, there are a considerable number of them that are full of interesting information. The United States Government mails these bulletins absolutely free of cost, and purely as a matter of courtesy.

We should like to see our own Government showing as much practical interest in the affairs of the citizens of the Dominion.

The Coal Strike Continues

UP TO THE time of writing, the prospects of a settlement of the strike in the United States coal fields seem remote. The shopmen's strike would seem to be in the neighborhood of a compromise, but nothing definite has yet been achieved. Meanwhile, although the days here are hot and sunny, each succeeding one brings the approach of fall a little closer. Our Government does not seem to think there is any cause for alarm, and is inclined to leave the whole matter to the coal dealers and agents. This, of course, is a very easy view to take, but we should imagine that with the knowledge of what a scarcity of coal in the winter means to this country, they would be well advised to take some more active measures. This is especially the case when there is a certain amount of restlessness evident among the miners in Nova Scotia, and the railway shopmen in this country are also thinking of indulging in the luxury of a trial of strength.

The final result is that the public are likely to be gouged when the cold weather actually arrives. If factories have to buy coal to keep their plants running at an exorbitant price, that means that the cost of the articles they are making will be raised in order to make up the difference. The unfortunate householder who has to buy coal in small quantities, and who cannot possibly do without it, no matter what sacrifices are entailed in the buying, has no choice but to dig into his resources and get what coal he can. He has no one to whom to pass on the cost.

It is nonsense to say that no crisis exists, and that everything will be quite all right, when trains are being suspended all over the United States because there is not enough coal to run them. The time to ensure that Ontario is to get a full supply of coal is now, while navigation is open. When the St. Lawrence is frozen up, and the railways have to contend against weather as well as crippled rolling stock it is hard to get coal even when the supply is plentiful. Here is a chance for a Government to achieve distinction by doing something of a real benefit to the people, but the chances of their doing it are, to say the least, not very hopeful.

Editorials in Brief

This is the time of year for picnics. The Toronto branch of the Canadian Asociation of Stationary Engineers are arranging for theirs to take place on the 19th of August, and hope to see a big crowd. Notice will be sent to members shortly as to time and place.

* * * *

The educational work of the various branches of the C.A.S.E. under the auspices of the Grand Lodge Educational Committee, is going to be something of great value to the members. The work will be started as soon as the hot weather is over, that is, with the first meeting in September of the various branches.

Progress in New Equipment

STEAM SUPERHEATER

The conditions of the modern power plant, especially of the central station type, call for a considerable degree of superheat in the steam supplied. There are very definite savings to be made by the use of superheated steam, which range from 10 to 25 per cent., depending on the type of plant. In the case of the steam turbine, superheat is an absolute necessity, and practically no turbine plants are now installed without this apparatus.

The following description of the modern development in superheating apparatus, is that of the superheater made by The Superheater Co., Ltd., at their factory in Sherbrooke, P. Q., and known by the name "Glesco." This is the type installed in the Hell Gate power plant of the United Electric Light and Power Co., New York.

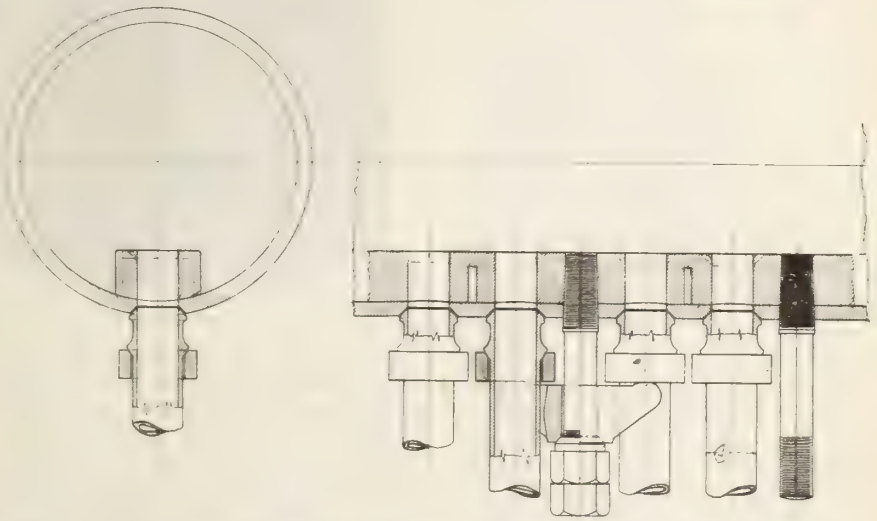


Fig. 1—Detail of Ball Joint Construction between leader and units.

Description

The superheater consists, in general, of two headers, one acting as the distributor for the saturated steam coming from the boiler and the other a collector header for the steam after it has been superheated, and the necessary connecting units in which the actual superheating takes place.

Headers

The headers are made of open hearth steel and are usually located outside of the hot gas path, and in the majority of the designs, outside of the boiler setting proper, so that the headers, as well as unit joints, are accessible for inspection and repairs without entering the boiler setting. The advantage of such an arrangement, particularly under present conditions of labor and supervision, will be readily appreciated. Safety valves conforming to the A.S.M.E. Boiler Code are provided and are located near the outlet. Provision is also made for drainage. Superheated steam headers are provided with thermometer wells.

The headers are made with the outlet on the superheated header in an opposite location to the inlet on the saturated header, assuring an even distribution of the steam flow through all units.

Each header is reinforced along its length with a steel bar milled on one side to fit the interior wall of the header. This detail is shown in Fig. 1. This bar adds the necessary material to provide a sufficient grip for the studs and is drilled along its length at points registering with holes in the header, forming the steam passages between units and header.

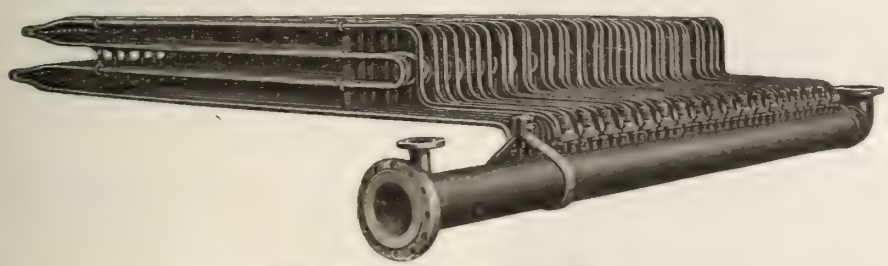


Fig. 2—Superheater for horizontal water tube boiler.

Units are made of heavy cold drawn, seamless steel tubing of the proper diameter to give correct steam areas. The tubing is not covered with any other material and it thus presents a smooth external surface, offers minimum resistance to the flow of the gases and avoids serious collections of soot that would interfere with the efficiency and uniform operation of the superheater. This construction also brings the steam into intimate contact with the gas-touched heating surface, and gives a low resistance to the flow of heat from the gases to the steam.

The form of the unit is such as to permit free expansion and contraction of all parts. The tubes are bent on specially designed machines that do not weaken them or reduce the steam areas. Ample provision is made to prevent the pipes from warping. In cases where severe moisture and scale conditions are prevalent, the units can be made so that they may be satisfactorily cleaned on the in-

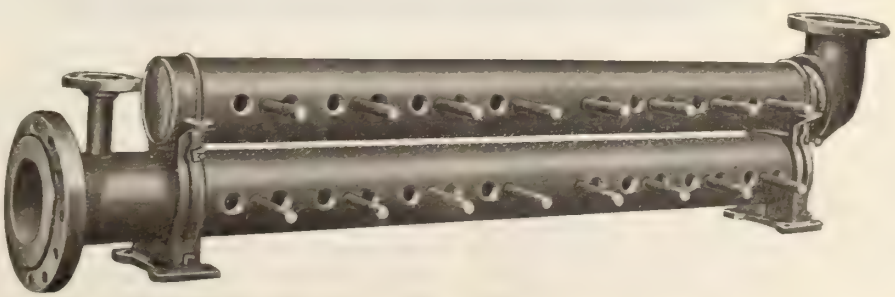


Fig. 3—"Elesco" Superheater ready for application of units.

side. Due to the fact that the units are made of small diameter tubing, it is possible to obtain correct relations between steam areas and heating surface and so distribute the cross sectional area through the superheater as to obtain the most desirable steam velocity without the use of cores. The use of cores in superheater tubes causes a considerable drop in pressure through the superheater, because of the added frictional resistance of the steam and where bad water and foaming occurs, the small space between the cores and the inside of the tubes is quickly stopped by scale-forming material.

The connection between the units and headers is a metal to metal joint. This joint is made so as to permit the easy removal of the units without special tools, and its use also avoids two holes in the header which would be necessary with rolled joints. Any unit in the superheater can be disconnected without interference with the other units, and the work of disconnecting a unit, which consists merely of loosening a bolt, can be done by the ordinary power plant attendant. The ball end, as shown in Fig. 1, is formed integral with the tube by a special forging process. The ball is then faced and ground, and fits into a ground seat in the header, which is made at an angle of 45 degrees. The clamps and washers are made of forged steel, and the header bolts are made of heat-treated alloy steel, with an elastic limit of not less than 75,000 lbs. per square inch. This joint, while a new departure in stationary superheater design, has been used by this company in more than one million five hundred thousand superheater units and is the only metal to metal joint that has withstood the extremely hard service of locomotive operation under steam pressure

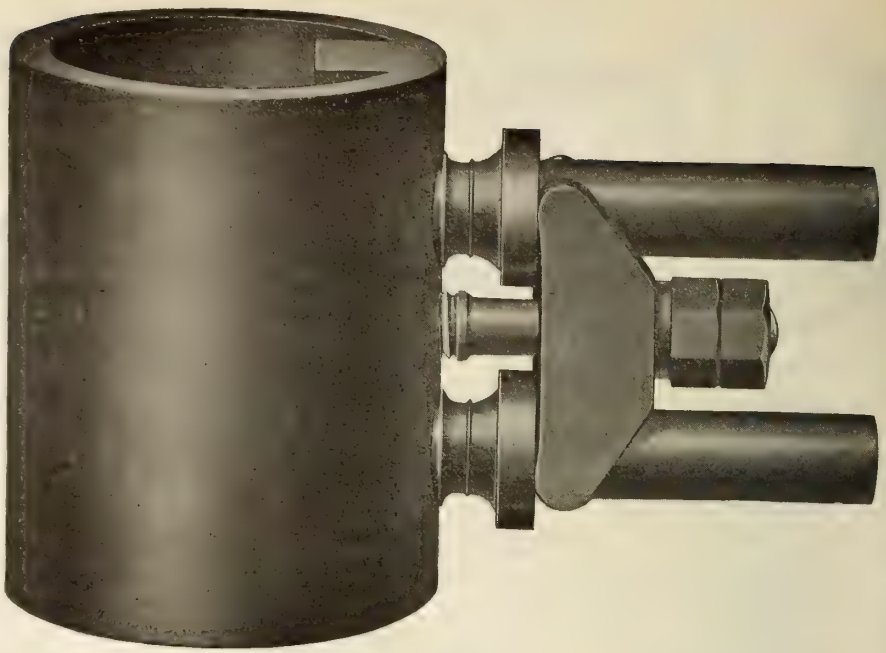


Fig. 4—Section of header and units showing ball joint construction.

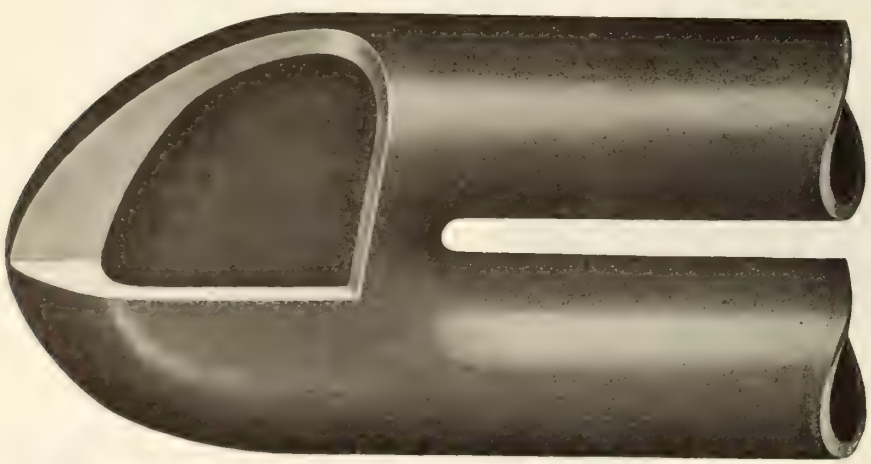


Fig. 5—Forged Return Bend.

of 200 to 225 pounds and total steam temperature of 650 to 750 deg. Fahrenheit.

Return Bends

In most designs of Elesco Superheaters, the loops of the units are forged return bends. These return bends are made on the ends of the units from the metal of the pipe itself by a special mechanical forging process, without the use of electrical or acetylene welding and without the addition of any material or metal. The distribution of the metal as will be seen in Fig. 5 is such that there is an increase at the end. The use of the forged return bend in the unit construction of the Elesco Superheater results in a continuous pipe, the bend being as strong if not stronger than the body of the pipe. It also affords a sharp return without adding excessive pipe friction and facilitates the convenient and advantageous location of the superheater units.

Location of the Superheater

The location of the superheater in all boilers is such that the headers and joints are accessible for inspection and repairs, and so that any unit can be easily withdrawn. In all cases the superheater is entirely separate from the boiler proper, being located in a component part of the boiler setting through which the products of combustion pass, in such a manner that the addition of the superheater increases the over-all efficiency of the boiler by lowering the final flue gas temperature for any given set of furnace conditions. The superheater header is suitably protected from the direct action of the hot gases. Headers and units are securely supported and are independent of the brick work wherever this is possible. No additional care of the boiler is necessary on account of the installation of the superheater, and the design and construction are such as to make the cost of maintenance and operation negligible.

With the ball joint construction, hand holes and gaskets for unit joints are entirely eliminated and the number of joints to be maintained is approximately one-fourth of the number required where rolled joints, including the necessary hand holes, are used.

In case boiler repairs may be necessary, units can be removed and replaced without distorting units or headers and without the destruction of metal in any way. Units can be readily detached, removed or replaced without the need of a boiler maker, it being necessary to remove but two nuts to loosen two units.

High steam velocity is used in Elesco Superheaters, a feature which tends to maintain clean surfaces on the inside of the units.

Units can be blocked off when necessary simply by relieving the pressure on the boiler and applying a dummy coupling to the unit connections.

These superheaters are suitable for application to all types of boilers. They provide maximum superheating efficiency and capacity and maximum combined efficiency of the boiler and superheater, as well as uniformity of superheating effect. Their design and construction is such as to provide freedom from leaks, ease of application and accessibility for inspection and repairs, and maximum length of service without renewal.

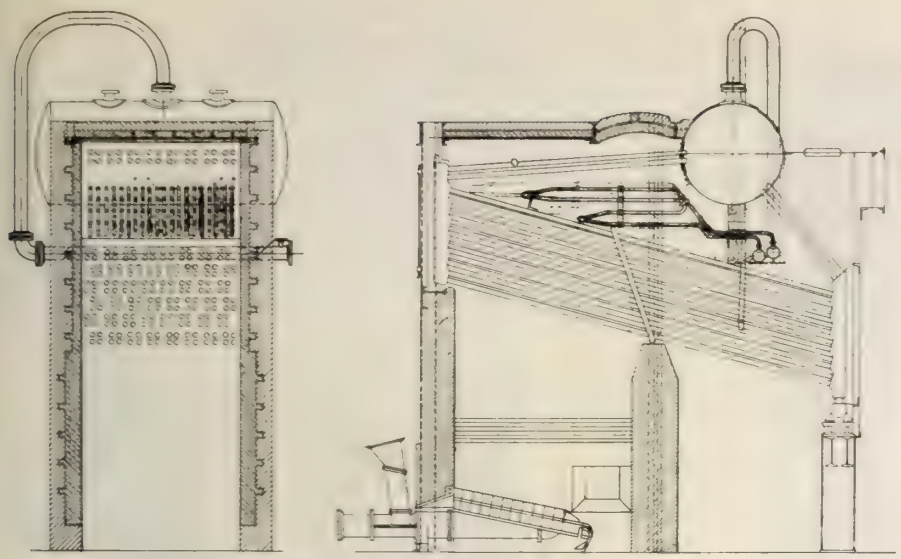


Fig. 6—Installation of Superheater in Springfield Cross Drum Water Tube Boiler

PORTABLE ELECTRICAL C. O. 2 & TEMP: INDICATOR

A clever instrument has recently been placed upon the Canadian market for the indication of the percentage of C. O. 2 in flue gases, and by the manipulation of a small switch the flue gas temperature may also be read on the same scale.

The idea is due to Dr. G. A. Shakespeare of Birmingham University, England, the instrument consisting of a galvanometer having two scales, the upper scale being graduated from 0 to 1,000 degrees Fahr., and the lower graduated in percentage of C. O. 2, a Katharometer, i.e., an instrument for indicating the percentage of C. O. 2 in air or the percentage of other similar mixtures, there being no chemical absorbant of the C. O. 2, and a base metal Thermo Couple for flue gas temperatures, and a multiway switch.

The instrument is entirely self contained, put up in a teak carrying case and very portable, weighing fourteen pounds.

The sensitive element consists of two platinum spirals encased in a metal block, the spirals being the fourth arm of a Wheatstone Bridge circuit, and the principle of operation depends upon the difference of temperatures of these two spirals.

One platinum wire is exposed to the gas through three small holes in the end of the metal block. The other is exposed to water which is contained with glass wool in a small brass tube fitted in the bottom of the case, it is only necessary to dampen the glass wool with water, therefore this seldom needs attention.

When the same gas, say pure air surrounds both spirals, the temperatures are the same, and the galvanometer records zero, 0% C. O. 2. When the gas drawn from the flue changes in composition the former wire changes temperature and the indicator pointer is deflected according to the percentage of C. O. 2.

Electric current is supplied to the Bridge by inert cells and provision is made to compensate as the voltage of the cells changes during discharging, the method of compensation is such that the cells do not require renewal for long periods.

Consider four bridge arms two of which are spirals of platinum wire having identical resistance under similar conditions. The other two arms are Manganin wire of equal resistance which is used to complete the bridge. Call the platinum spirals A & B, and the Manganin wires C & D.

If a battery and switch are inserted in this circuit, and the switch closed. a current will flow through the bridge arms.

This will cause heating and change the resistance of the four arms. If conditions are the same around the different arms of the bridge then C & D will lose heat at the same rate, and likewise A & B, consequently, if C & D were equal and A & B were of equal resistance before switch is closed, they will be of equal resistance after.

Therefore the bridge will remain balanced, and the indicator or galvanometer will not be deflected.

Now suppose that the space in the block surrounding the spiral A is filled with a substance that is a better conductor of heat than that around B. Then the heat being conducted away from A faster than from B, will result in A being maintained at a lower temperature and consequently a lower resistance than B. This causes the bridge to be unbalanced, which will be shown by a deflection of the indicator.

The instrument can also be used as a temperature indicator for temperatures up to but not exceeding 1,000 Fahr., without the cells being connected and separate and distinct from C. O. 2 indications, in the manner of an ordinary indicating pyrometer.

This instrument is designed particularly for measuring the percentage of heat going up the stack. For a determination of this it is necessary to know:—

(a) The excess of air; this is given by the C. O. 2.

(b) The rise in temperature of the air from the inlet to the base of the smoke-stack.

The per cent. heat loss can then be calculated from the formula

$$\%\ \text{loss up chimney equals } K.\frac{(t_2 - t_1)}{C}$$

where t1 and t2 are the initial and final temperatures of the gas before and after passing through the fire and economizer.

C equals percentage of C. O. 2 in outlet gases.

K equals a constant depending on the composition of the coal burned.

Any engineer who has used a portable instrument of the chemical reagant type, with caustic potash will easily realize the immense value of the instrument described above, especially to inspecting and consulting engineers.

The manufacture of this instrument is due to the Cambridge & Paul Instrument Co., of Cambridge, England, and has been placed upon the Canadian market by their Canadian branch, Messrs. Instruments Ltd. of Ottawa.

CAST IRON AIR TIGHT DOOR

A new cast iron door, 15″ x 16″, has recently been developed by the Conveyors Corporation of America, Chicago. It is designed especially for boiler settings, and is made air tight to prevent the ingress of air and the leakage of gases.

The door is strong and substantially built, having both frame and door of cast iron. All bearing surfaces are machined to make an air tight contact. Floating hinges pivoted to the door at the center insure an even pressure over the door when it is closed and locked. The door can be provided with either of two types of locks—with a wing nut at the end of a hinge bar, or with a lever locking device which is recommended when the door is subjected to frequent opening and closing.

BOOKLET

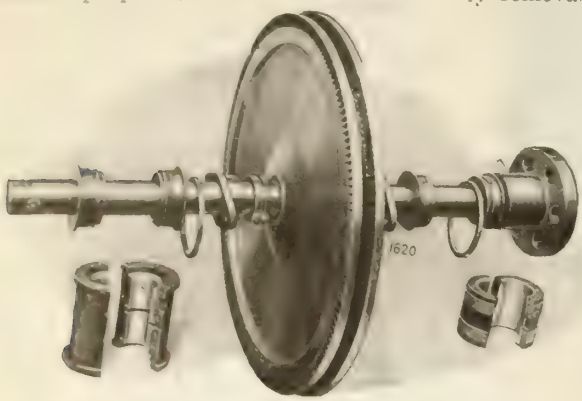
The Automatic Fuel Saving Co. have sent us their booklet describing the Gray system of automatic combustion control. Their representative for Canada is Mr. Chas. N. Green, 825 Chamber of Commerce, Buffalo, New York. The system is a balanced draft arrangement, and the booklet gives full particulars and illustration of the device and its method of installation and operation.

TO MANUFACTURE BABBITT

The Georgian Bay Spring & Babbitt Works, have erected a new factory in Collingwood, Ont., and are preparing to manufacture a high-grade British babbitt. This product will be introduced to the trade as Gray's special No.'s 1, 2, and 3. The company also contemplate the manufacture at an early date of automobile springs.

SMALL STEAM TURBINES

Small steam turbines, as used for driving power plant auxiliaries, such as exciters, circulating pumps, hot well pumps, hurling water air pumps, boiler feed pumps, coal crushers, fans and stokers, etc., ordinarily receive, and should demand, but little attention. They should also be able to use steam at high pressure and superheat, and for their size, should develop the maximum amount of work from the steam, even though the latter is subsequently utilized in feed water heaters or for industrial purposes.



Rotating element and bearings of De Laval velocity stage turbine.

The velocity stage turbine illustrated herewith has been designed to meet these requirements. It is built in sizes up to 1,200 h.p., and can be directly connected to high head centrifugal pumps, blowers and compressors, or by means of speed reducing gears, to medium size alternators and direct current generators, to large centrifugal pumps and blowers, to belt pulleys and rope sheaves, to paper machines, to rolling mills, and to other slow and moderate speed machinery.

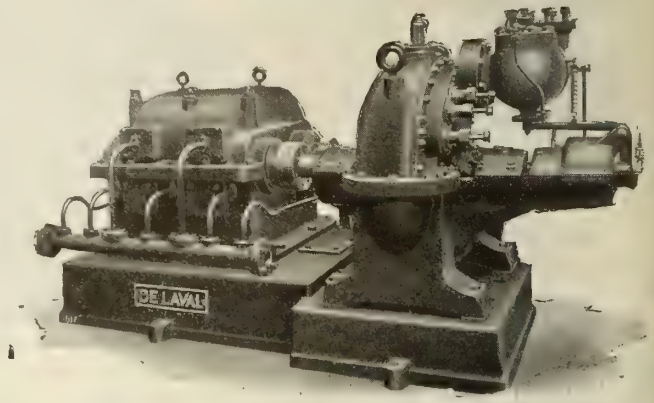
To adapt it for operation with steam of high pressure and superheat, the steam chest and nozzles are located in the casing cover, so that the bearings are not subjected to high temperatures. Since the steam is completely expanded in the nozzles, the turbine case contains steam at exhaust pressure only. For all steam temperatures above 450 deg. F. and for steam pressures above 210 lbs. gage, the steam chest, governor valves, emergency governor valve casing and strainer casing are made of steel.

From the steel steam chest the steam expands through removable nozzles, which are accurately reamed for the ratio of expansion desired. Some of the nozzles are fitted with hand valves so that certain nozzles may be shut off or opened as required by the load or steam conditions, thus permitting the nozzles remaining in service to work at the highest efficiency. The nozzle ring is attached to the steam chest and is easily removable.

The wheel carries two or more rows of buckets, depending upon the speed and steam conditions. The buckets are drop forged from materials best suited to resist the corrosive and erosive action of steam, and are secured to the rim of the wheel by bulb shanks in such a way that individual buckets can be removed without disturbing others. The steam discharged from the first row of buckets passes through guide vanes which direct it upon the succeeding row. These guide vanes are held in removable steel segments attached to the nozzle plates, so that it is a comparatively simple matter to replace them if damaged or worn by long use with wet steam.

The admission of steam to the steam chest is controlled by a speed governor which acts upon a double seated valve. Where the volume of steam to be handled is large, or speed is high or very close speed regulation is desired, the governor is of the Jahns type, mounted on a vertical spindle, which is driven by the turbine shaft through a worm gear. A more simple type of governor, mounted directly upon the turbine shaft, can be used on small and medium sized turbines running at moderate speeds, or where a speed reducing gear is used the governor may be mounted upon the slow speed gear shaft.

The turbine is also equipped with a safety or emergency governor consisting of a small plunger set radially in the shaft and acting against a strong spiral spring. When a predetermined speed is exceeded, this plunger projects

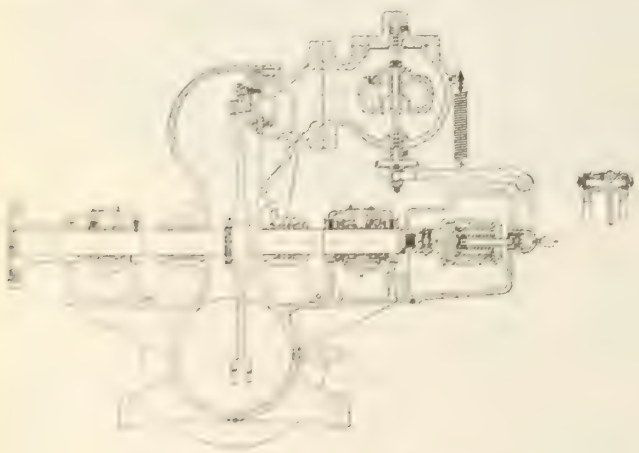


De Laval velocity stage turbine with speed reducing gears; 3,600 to 415 r.p.m., 175 h.p.

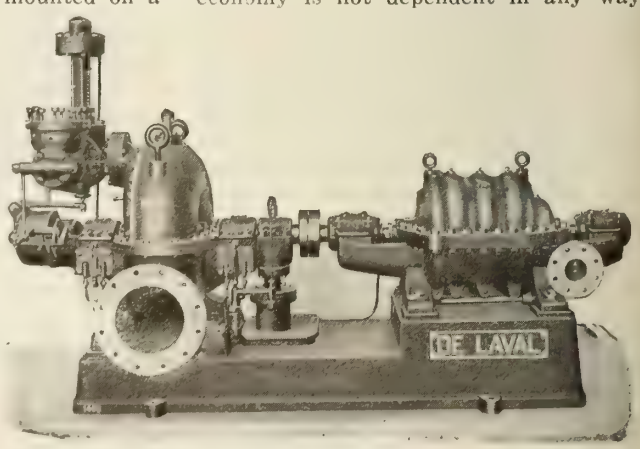
because of centrifugal force and strikes a small lever, tripping a mechanism which immediately closes the emergency valve. This emergency trip or overspeed governor is always mounted on the turbine shaft, and its action is entirely independent of the main speed governor. The valve which is tripped is entirely independent of and separate from the valve used for governing purposes.

The turbine case is divided horizontally so that the top half of it may be removed, giving access to the rotating elements. Upon removing the cover, the rotating parts can be lifted out.

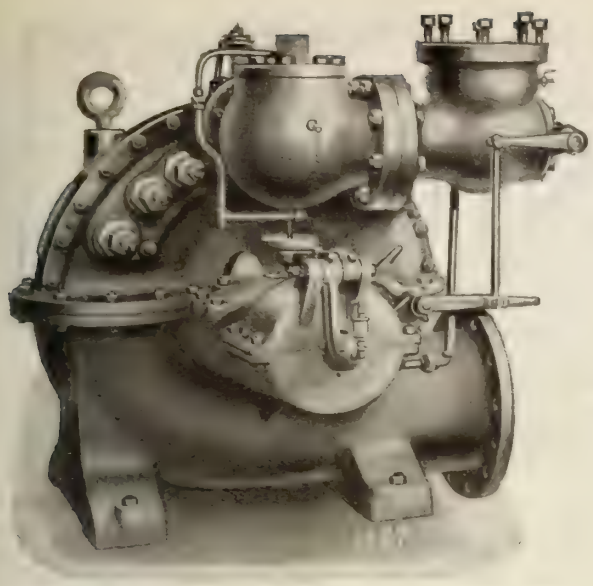
Since the steam is completely expanded in the nozzles, the turbine case contains steam at exhaust pressure only, but an automatic sentinel valve is provided to give warning of excessive pressure in case a valve in the exhaust line be closed. There are no stuffing boxes or packings within the wheel case, and economy is not dependent in any way



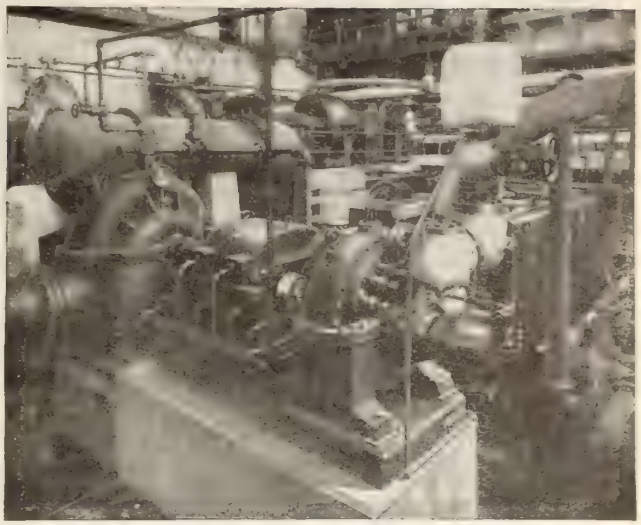
Axial section of De Laval velocity stage turbine.



De Laval velocity stage turbine driving boiler feed pump, 400 gal. per min. against 635 ft. head at 2,500 r.p.m. Turbine fitted with excess pressure governor.



De Laval velocity stage turbine for high pressure temperature steam, showing location of steam chest in casing cover, removed from bearings; also showing the speed governor and valve and the separate shut-off valve controlled by an automatic overspeed trip.



De Laval geared velocity stage turbine driving condenser circulating pump in water works pumping station; 17,500 gal. per min. against 30 ft. head.

upon the maintenance of small clearances. To prevent leakage along the shaft where it penetrates the casing, metallic ring packing is used. For high speed and certain conditions of service, carbon ring packing is employed.

The wheel is a steel forging mounted on the shaft by a taper fit. The shaft is of hammer forged steel, sufficiently short and stiff to put its critical speed far above the running speed.

This turbine is being placed on the market by the De Laval Steam Turbine Company of Trenton, New Jersey, primarily to meet the demand for reliable and efficient auxiliary turbines where high steam pressures and superheats are used. It is, of course, equally satisfactory for less severe steam conditions.

All parts of the turbine are made to limit gages on an interchangeable basis. The system of production control includes skilled engineering supervision, careful purchase and rigid inspection of materials, high quality and accurate workmanship, and complete testing of the finished machines.

STRIKES AND BETTER BUSINESS

Delay in reaching settlements of present labor troubles will temporarily delay expansion, but it will not affect the fundamental causes which for more than a year have been making for better business, declares a New York authority on the situation in the United States.

Conditions at the close of the first half of 1922 indicate that business will expand moderately during the autumn and winter months. It is now one year since the definite beginning of recovery from the depression of 1920-1. Progress was slow until the close of 1921, but since the beginning of 1922 improvement has been rapid. Money is cheap. The crop outlook is excellent. With few exceptions, stocks of raw materials and of manufactured products are not larger than necessary to bridge the normal period between production and consumption. Commodity prices are rising. The movement at present seems to be primarily one of adjustment between the different classes of commodities, and as long as the upward tendency does not assume a speculative character, it is a favorable factor. Except for strikes, there is little idleness. Production has expanded steadily since the beginning of the year, and as yet the usual mid-summer dullness has been little felt.

RURAL POPULATION LEADS

The final figures issued from Ottawa of the sixth census, as of June 1st, gives Canada a population of 8,788,483, an increase of 1,581,840 over 1911 or 21.95 per cent. The census figures show 4,439,505 of the total population residing in rural districts as compared with 4,348,978 living in urban centres. Ontario is leading the way among the Provinces both as to total population and in the number living in the country. Ontario's total population is 2,933,662, of whom 1,226,292 live in rural districts. Quebec is second with a total population of 2,361,199, of whom 1,038,128 reside in the country.

FEAR COMPETITION

According to the proposed rates on machine tools, as framed before Congress at Washington, D. C., the duty on machine tools would be raised to 35 per cent. Should this move go through, it would be the highest rate in force since 1897. In 1909 the rate was 30 per cent., in 1913, 15 per cent., so that the proposed increase is quite drastic. Certain American manufacturers are afraid of German and perhaps British competition, and should the proposed duties go into effect, this competition would automatically cease. Whether the rating goes through is another matter.

Australia has stolen a march on Canada by entering into an agreement with the British Government under the Empire Settlement scheme. Canadian parliament has prorogued without passing the necessary legislation. The plan as proposed will be operative until March, 1923 and will cost £400,000. There will be a grant to desirable immigrants of one-third of cost of passage, another third will be loaned at a low rate of interest, and even the remainder may be advanced if necessary. Initial allowances may also be granted. Australia, owning its own steamers, will make the expenditures and will be refunded one-half by the British Government. Only immigrants proceeding under settlement or development scheme, or assured of other employment in Australia will be eligible for these assisted provisions.

Through lack of power industries at Belleville were completely tied up during the latter part of the week. The situation in Peterboro also threatened, when several factories were compelled to shut down. At the latter place the trouble is said to have been caused by restricting conserved waters, causing a difference in levels, but, on the other hand, the cause is attributed to evaporation. Some difference of opinion seems to exist as to water rental per horsepower and the matter is one that has to be threshed out between the Hydro Commission and Ottawa Government. The Department of Railways and Canals ask a rental of $3.50 per horse power, which is claimed to be exorbitant, and had cut down the supply at hydro stations. As a result industries in several towns are crippled. Formerly, the rates had averaged $1 and $2 and it was claimed that some power concessions in other provinces were securing water from the Dominion free of charge. The Province of Ontario is charging a maximum of 50 cents per horse power.

Management of Direct Current Machinery

By M. BARRY WATSON
Director of Engineering, Toronto Technical Schools.

BADLY developed high bars, flat spots, high mica, low bars or ec centricity of the commutator can only be entirely corrected by turning with tools on a rigid support, or by grinding.

Previous to turning or grinding it is necessary to make sure that the commutator is tight. If not tight make it so by screwing up the clamping ring under the outer end of the bars. Most commutators require to be tightened up after the first six months running and again after a couple of years, after that they should stay tight for life. The examining for looseness and the tightening, if any, should be done immediately after a run while the commutator is still warm.

A commutator may be turned in its own bearings or in an engine lathe. If in its own bearings, it may be driven at reduced speed by belt or otherwise, or it may be run as a motor on normal voltage at reduced speed by putting a resistance in series with the armature circuit.

The tool post should be built up from the frame of the machine, not mounted on the brush holder mountings. In case the machine is being run as a motor, the tool post must be insulated from the frame of the machine and not allowed to come in contact with brush holders, etc. If belt driven the brushes should be removed.

In turning a commutator it is necessary to use a tool with quite a sharp point, but sufficiently rounded that the cuts will overlap and not form a thread, therefore the feed must be very slow. Light cuts must be taken, several cuts being necessary to remove large bad spots or excessive eccentricity. If deep cuts are taken the bars tend to lean over as they are being cut and when they spring back the leading edge will be slightly lower than the trailing edge. If at all possible it is better to remove the armature to a lathe on account of the difficulty of building up a tool post that will be perfectly rigid. The surface speed of the commutator in turning should be about 500 to 600 feet per minute. This surface speed can be calculated as follows:

S = 3.14 x D x N, where S=Surface speed in feet per min. D=Diameter of Commutator in feet, and N=Revolutions per minute.

Before starting to either grind or turn a commutator, the open spaces between the windings should be covered with oilcloth or canvas to prevent chips or dust of copper from lodging in the interstices. This covering must be securely wrapped on to prevent flying off or catching in the tool post or grinder.

Grinding may be done by a stationary stone held firmly in the tool rest or prevent chattering or digging into the commutator, in which case a smooth sand stone similar to a hand stone should be used. The surface speed of the commutator for stationary stone grinding should not usually exceed 1,000 to 1,200 feet per minute.

A rotating abrasive wheel is much to be preferred for grinding to a stationary stone, as it will not chatter or dig into the commutator as a stationary stone may. A medium soft stone must be used to prevent the face filling up with copper. Grinding with a wheel should preferably be done in a machine's own bearings at normal speed, as this will compensate for any distortion which may take place in the shaft when running, due to unbalanced armature.

Special machines are available for grinding commutators and may be attached to the brush holder rigging if desired. Light cuts must be taken both to prevent excessive wear on the stone and to prevent springing of the armature shaft which would tend to reproduce high or low spots. If the commutator is badly out of true, the rough cuts should be taken at medium low speeds and the finishing cuts made at normal speed.

The final surface is best finished by means of a hand stone. More care is required in the finishing of a turned than of a ground commutator because of the threading action of the tool. Turning removes the metal from the commutator somewhat quicker than grinding but does not give quite as true a surface and therefore requires considerably more hand finishing.

The cleaning of the whole of the machine is of the greatest importance after turning, grinding, stoning or sanding the commutator. To make sure that no copper dust has got in where it will do harm, a test of the insulation to ground with about 1,000 volts may save future trouble.

Some Causes of Commutator Troubles

High or low bars are usually the result of loosening up of the commutator. Tighten it up and turn or grind till true. Flat spots may be caused by any of the following causes: Sparking, instantaneous overloads or surges, unbalanced armature, difference of hardness of the various bars or strips of mica. A black commutator is caused by too much lubricant or excessive sparking.

Heating may be the result of: Excessive sparking; local short circuits due to brushes off the neutral, too thick brushes, brushes at too flat an angle, brushes not properly spaced, bent brush holder stud or unequal air gaps between armature and poles, too high brush pressure; too high friction quality of brushes; sand under the ends of the brushes. This last condition is usually shown by copper dust on the brushes or holders. Copper dust will also be picked up if too much lubricant is used or too abrasive a quality of brushes. Noisy brushes may be from any of the following causes: Too much friction; rough commutator; dirty commutator; high mica; high or low bars or flat spots on commutator; eccentric commutator; or loose brushes.

Commutator Slotting

The slotting or undercutting of commutators consists of removing the insulation from between the bars of the commutator to a depth of 1/32 or 3/64 of an inch. This leaves only the copper bars in contact with the brushes.

With flush commutators the brushes used must be hard and have considerable abrasive action to cut away the mica as fast as the copper bars wear away in order that the brushes may make good contact with the copper bars. Abrasive brushes mean more wear and thus shorter life for the commutator, as well as heat and the loss of power from the extra friction.

The undercut or slotted commutators, brushes with very little friction and practically no abrasive action may be used saving the above wear and power losses. On an average machine with flush commutator, the brisk friction may amount to as much as 2½% of the total capacity of the machine. To illustrate the cost of this waste power, consider a 100 k. w. generator operating 10 hours per day, 300 days per year. The total power generated in this time, if machine is fully loaded, is 300,000 k. w. hours. The total power lost in brush friction will then be about 2½% of this or 7,500 k. w. h., which if power costs 1c per k. w. h. will mean a loss of $75 per year most of which might have been saved if low friction brushes had been used.

It sometimes falls to the lot of an operating engineer to re-undercut a commutator which has worn or been turned down to the mica, or to slot the commutator of a machine which originally had flush mica between the bars.

There are several machines on the market for this work all of them fairly satisfactory. The usual power outfit consists of a small milling saw which can be conveniently mounted on the machine. There are also numerous hand tools of special type. The commutator slotting file is probably the simplest and easiest to operate. A properly ground tool operated on a lathe tool carriage may be used with success if available. Broken hack saw blades are sometimes used, but require great care in their manipulation to prevent scratching the surface.

After slotting make sure that no thin strips of mica are left flush with the surface of the commutator. It is well to scrape the slot with a V-shaped tool to slightly bevel the edges of the copper bars, and to detect any chips of mica left too high as well as to remove burrs of copper which if left in the slots would likely cause short circuits and serious burning.

After undercutting, the commutator should be polished according to instructions given above to remove any slight scratches and give a high polish, as the brushes to be used with it have little if any polishing action, and are so soft that even minute scratches will cause excessive brush wear.

Lubrication is unnecessary on undercut commutators, as the brushes have very little friction, especially if of the self-lubricating grades, and oil and grease on the commutator would only serve to collect carbon dust in the slots. If oil is likely to creep into the slots from the bearings or to be splashed onto the commutator, the slots, after being thoroughly cleaned may be varnished with good insulating air drying varnish. They can then easily be washed out with gasoline at any time.

Selection of Brushes

In times past the average operator when in need of brush replacements merely ordered "Carbon Brushes" of the size required from his dealer, and accepted what he received without question, placing the blame on the machine or the load or other conditions if commutation were not good. He generally tried to remedy any trouble by increasing the brush pressure to prevent sparking or by lubricating too freely to prevent wear.

It is only within comparatively recent years that the physical and electrical characteristics of carbon brushes have been seriously studied in connection with their commutating behavior under various conditions.

It is too much to expect that every operating or maintenance engineer should go thoroughly into the question of brush characteristics, and their relationship to operating characteristics. Brush manufacturers on the other hand maintain a staff of research engineers who have available all information on these subjects; and by submitting the conditions under which any machine is operating to them, the proper brush for that machine can usually be recommended by them. Often these brush engineers are available without charge to investigate particularly stubborn cases of poor commutation, they will make a thorough analysis of the conditions of operation and will be able to prescribe the type and quality of brush to most nearly satisfy all the conditions.

Below is a list of data which a brush engineer must have to intelligently select the proper brushes for any particular machine.

1. Size of brushes, number of sets of brushes per set.
2. Whether generator, motor or rotary converter.
3. Direct or alternating current. If A. C. number of phases.
4. Whether for commutator or collector rings.
5. If commutator, whether slotted or not, if collector rings, whether of iron, steel, brass or bronze, etc.
6. Voltage of machine.
7. Full load current.
8. Speed in r. p. m.
9. Diameter of commutator or slip rings.
10. Number of main poles.
11. Whether machine has commutating poles.
12. Type of brush holders, and shunt connections.
13. Degree of bevel on end of brush.
14. Width of commutator bars, or number of bars.

Also name, grade number etc. of brushes which have been in satisfactory use, or preferably a sample, and conditions of brush pressure, lubrication, etc., under which they were satisfactory. Or complete data regarding the manner in which samples submitted have been unsatisfactory in operation.

Most brush manufacturers supply free complete data sheets with spaces for the above information to be filled in. If these sheets are used in ordering brushes, one is sure to get a satisfactory brush, provided the machine is in good order otherwise. Brushes should always be ordered in this way, or at least until some definite grade of some manufacturer's brushes has been found to be perfectly satisfactory, when they may be ordered by catalogue or grade number from that manufacturer of that particular machine.

Brush manufacturers usually have lists of the standard sizes and makes of machines, for which they have determined the proper brush. In this case it will be necessary to give only the nameplate data of the machine to receive the correct brushes.

Just because a brush gives satisfactory commutation on a machine does not mean that it is the best brush for that machine. It may be wearing away the commutator too fast, or be developing too much friction, or too much resistance in the circuit, or too little control resistance resulting in high short circuit currents, any of which things tend toward loss and inefficiency.

Summary

The care and maintenance of D. C. machinery thus resolves itself into cleanliness, the proper care of bearings and lubrication, care of commutators, and the proper selection and use of brushes. Needless to say defects should be remedied as soon as possible after they become apparent.

The best engineers do their cleaning regularly and thus generally discover minor defects before trouble occurs which brings the defects forcibly to their notice and saves a large repair bill to the owner.

Alternating currents are described as those which, rising and falling in strength, flow alternately in opposite directions at regular intervals. The currents vary in intensity from a plus maximum to a negative maximum and are separated by points of zero pressure as distinguished from a direct or continuous current.

A commutator is that part of an armature which reverses the direction of electric currents in any circuit. It consists of copper bars or segments, side by side, forming a cylinder and insulated from each other, ordinarily by sheets of mica. It rotates with the armature and the conductors of the latter are so connected with the segments of the commutator that the current taken off by the brushes bearing upon its surface are direct although an alternating current is generated by the armature itself.

The Operators' Point of View

A DIGNIFIED PROTEST

The Editor, Power House,

Dear Mr. Editor:—

With reference to Mr. J. A. Carruthers' letter in the issue of Power House, July 20th, I crave permission to make a few remarks.

Mr. J. A. Carruthers, I think, has taken a ridiculous interpretation of the requirements of the Ontario First-class Engineer. A 200 horse power motor driven air compressor being a thing only seldom, if ever, met with, and then only in large plants in conjunction with steam apparatus. I do not intend being drawn into a controversy regarding the relative values of engineers' examinations in the different provinces, such being in my opinion merely small talk, but there may be readers of the Power House who may attach some weight to Mr. Carruthers' letter, and to them I make these remarks.

Before me, I have a copy of the "Alberta Steam Boiler Act," which plainly states that an applicant for First-class Certificate must furnish proof that he has been employed as a machinist, or boilermaker, at repairing steam engines or boilers for not less than 24 months, and that he has had charge and operated a battery of boilers and engines of not less than 300 horse power for a period of at least 12 months.

So why the disparity regarding the Ontario man?

W. J. Scott,
91 Pacific Ave., Toronto.

HOW ABOUT THIS

There is one thing with which many engineers are afflicted, a thing which tends to hold them back, to leave a wrong impression upon the mind of a stranger. The thing I refer to is a man's inability to talk freely to strangers or in public, in the lodge room or in his trade meetings. They may be good men in their particular line, it makes no difference. Among their everyday workmates they can, to use a slang expression "talk a fellow's leg off," but when in strange surroundings they become tongue-tied or vague in their conversation. I know, I am such a sufferer myself. Many a time after an interview I have cussed myself for a "bonehead" because I had become rattled. It has been stated that a complete knowledge of the subject under discussion and a confidence that you know the subject will prove a cure. I doubt it. Note the loud-spoken, know-it-all, but-really-know-nothing-fellow. He will talk you deaf, dumb and blind, and still say nothing. The poor chap who really could say something if he could remain normal finds it impossible to remain in this desirable condition, his voice gets husky, he perspires freely, and he talks about anything which enters his mind although he knows it will not be of any interest to his listeners. Personally I believe it is extreme shyness caused by a nervous temperament. What I am trying to suggest is not to misjudge a fellow when he tries to get off a speech and suddenly becomes tongue tied. It is the same when he tries to demonstrate on a blackboard, he knows exactly what he is going to write until he gets the chalk into his hand, then his mind becomes a blank. In familiar surroundings he can scribble stuff by the yard. Perhaps the lad who attends the meetings and never has a word to say or a thing to do is in this class. He may be eager to help but lacks the nerve, gall, moral courage, call it what you please, he may have all kinds of confidence in his own knowledge, it makes no difference. What is the cure I wonder. It is useless to advise him to talk slow, to take his time, etc., the ailment needs different treatment. Perhaps some of your readers would be glad to hear about a real cure. I know I would.

Owen Glendower.

Editor's Note

The trouble experienced by our correspondent is unfortunately only too frequently found among men of real ability. There have been some thousands of cures recommended, advertised, and sold by those eager to exploit the failings of their fellow men, but the cure for this trouble must come from within. It is a matter entirely of the mind, and is born of self-consciousness, begotten sometimes by nervousness, and sometimes purely shyness. It is a very serious handicap, and we have known some real good engineers who could not pass a verbal examination because they became a mass of nerves under the ordeal.

The only way to cure it is to think of the subject and not of yourself. Get away from the idea that everyone is watching for you to fall down, and realize that if you have anything to contribute that is worth while, your hearers are only too willing to hear you. Speaking in public may be a trying ordeal, but face the ordeal. After all, nothing very serious can happen to you. You could say all these things in a little circle of four or five intimate friends. Why not say them to 20, 40, or 100 if you have to.

This is one of the things where the meeting of a number of engineers in the room of their association can be of the greatest usefulness. This is the place where the man who is backward in placing his views on record should be encouraged, and the chairman or president of the gathering should encourage that type of man to speak, rather than those who are only too willing to speak on every occasion that arises, or even make occasions if none really exist.

FOOT VALVES ON PUMP SUCTION

Question:—The suction lift of a pump is approximately twenty-five to thirty feet. I have been told that I could get water with a suction lift of 50 to 60 feet by putting in valves 20 feet apart. If I have a lift of 40 or 50 feet and can get water with the valves does it matter if the valves are equally spaced?

Answer:—Whoever told you that putting foot valves on will enable you to lift water from a depth of 50 or 60 feet is mis-informed, and has not a clear understanding of what is entailed in the operation of pumping water from a depth. The absolute limit of lift with a pump which has an efficiency of 100 per cent, by which we mean that there is no slip and absolutely no losses due to friction of the water in the pipe, is 33.8 feet, which is the height of a column of water which could be supported by the pressure of the atmosphere 14.7 lbs. As no pump is 100 per cent. efficient, the maximum lift is something less than this and in practice rarely exceeds 26 feet.

There is, strictly speaking, no such thing as suction of a pump. What happens is that the pump plunger or piston exhausts the air from the suction pipe, and the pressure of the atmosphere forces the water up the pipe and into the pump. Obviously the greatest lift possible cannot be more than the height corresponding to the pressure of the atmosphere. This height is found from the formula $P = .434H$, or $H = 2.304\ P$, where P is pressure per sq. inch, and H is height in feet.

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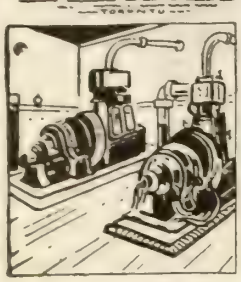

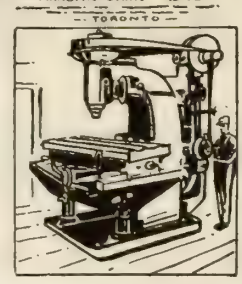

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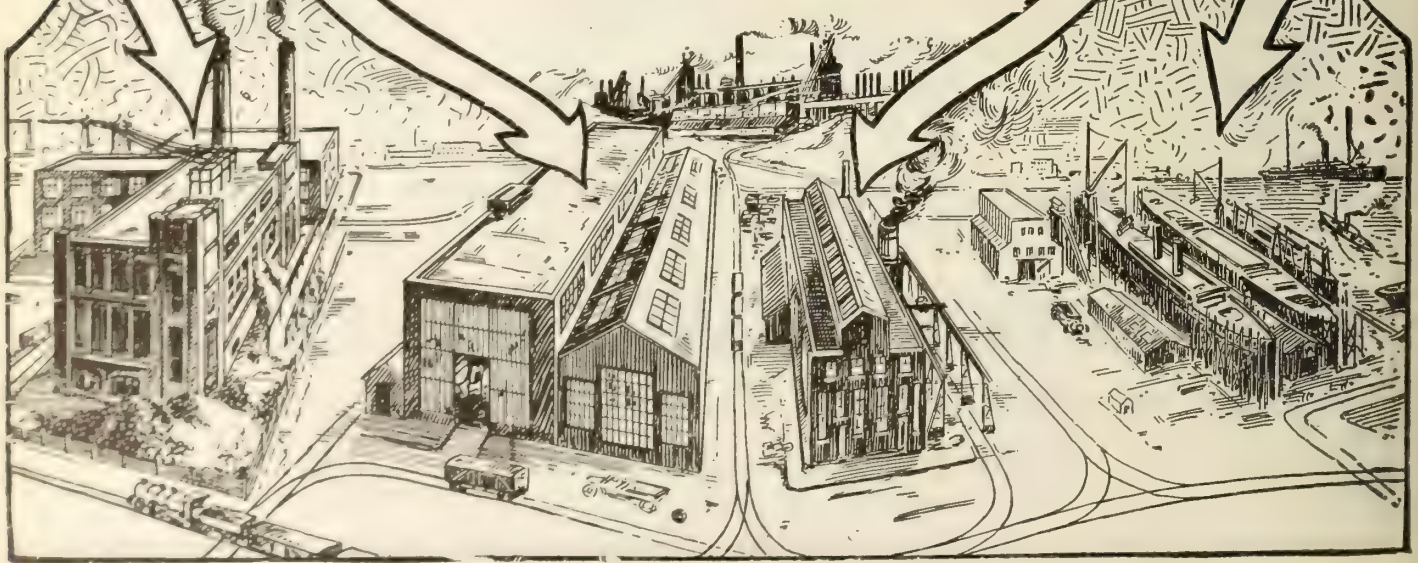

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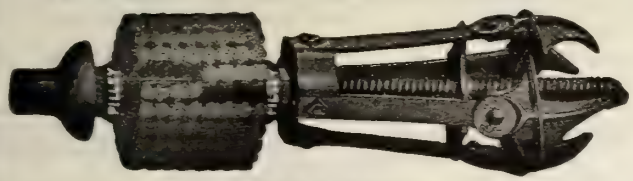

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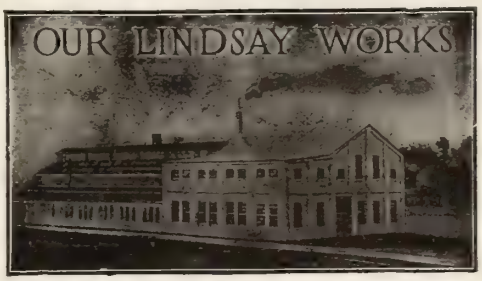

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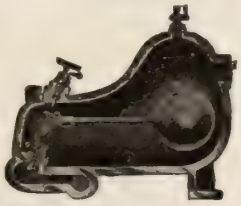

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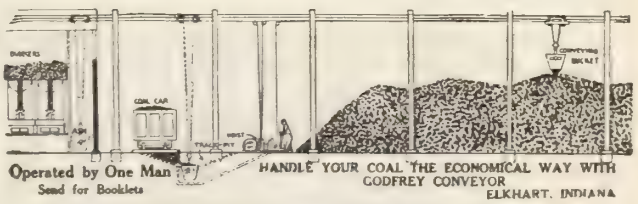

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H. W. PETRIE, LTD., 131 FRONT STREET W., Toronto, sell new and used boilers, engines, air compressors, electric motors, machine tools, wood-working machinery, transmission equipment and small tools; get our prices for machinery on monthly rental.

When answering this advertisement, mention this paper. P.F.H.

SITUATIONS WANTED

STATIONARY ENGINEER — SECOND CLASS, requires position, ten years' experience of steam generation, refrigeration, cold storage and electric generation, thoroughly experienced with heating systems and hydraulics and all classes of stationary engines, used to large plants, good references. Apply to Box 5122. P.3H.

DIE SINKER — THOROUGHLY PROFICIENT in all kinds of first class work. Apply Box 107, Power House. PFH

ENGINE FOR SALE.

1 only 15" x 34" Wheelock Engine, 125 H.P. also H.R.T. Boilers, 5' 6" x 15' all in good condition—for immediate delivery. Apply Steel Co. of Canada Ltd., 1272 Notre Dame St. West, Montreal, Que.

M. BARRY WATSON

B. A. Sc., C. E., M. E.

Associate Member Engineering Institute of Canada.
Member American Society of Mechanical Engineers.

Consulting Engineer

Power Plants
Heating—Ventilation—Lighting

192 Arlington Avenue, Toronto
Hillcrest 6976W

Superintendent

OR

Chief Engineer

With wide mechanical and electrical experience, best references and connection.

Open for Engagement

Address today to Box 103

POWER HOUSE
143 University Ave., Toronto.

When Writing To Advertisers Kindly Mention Power House

NORTHERN CRANES

NORTHERN CRANE WORKS, LTD.
Wauseon, O.

VICTORIA FOUNDRY COMPANY, LIMITED

Engineers, Machine and Foundry Contractors
OTTAWA, CANADA

Special Castings *Forgings*

Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.

Send Blueprints for Quotations. *Write for our latest catalogue*

Patterns *Machine Work*

"A type to meet every stoker need"

SANFORD RILEY STOKER CO.
WORCESTER, MASS
RILEY STOKERS

MURPHY IRON WORKS
DETROIT, MICH
MURPHY AUTOMATIC FURNACES

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND CINCINNATI CHICAGO ST. PAUL KANSAS CITY DENVER

Get the Most Out of Your Fuel

THE BOILER D. M. LIFE SAVER

Keeps your boiler clean and thus eliminates repair bills, besides reducing maintenance cost.

Will not injure boilers or fittings.

No acid—No chemicals—Just "D. M."

"D.M" Boiler Enamel is a Vegetable composition, absolutely harmless, and will keep your boilers clean right down to the bare metal. Prevents all scale formation, corrosion and pitting. "D. M." Boiler Enamel is used by many of the largest users of steam throughout the world including the British Government.

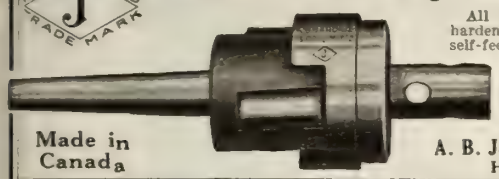
Manufactured by: HOUSEMAN & THOMPSON, Ltd., Newcastle-on-Tyne, England.

Sole Distributor for Canada:

J. A. CARRUTHERS - 23 Scott St., Toronto

REGISTERED J TRADE MARK

Jardine's Self-Feeding Tube Expanders

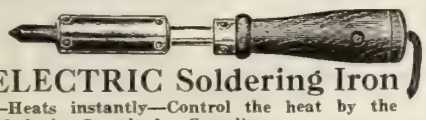


All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel, it is withdrawn without danger of breaking mandrel or straining expander.

Made in Canada

A. B. Jardine & Co., Ltd.
Hespeler, Ont.

VIMY



ELECTRIC Soldering Iron

Just push the button—Heats instantly—Control the heat by the handle—Made in Canada by Canadians.
Good Proposition for Live Dealers.

The Vimy Supply Co., 576 College St., Toronto

INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE

OF POWER HOUSE

Classified Opportunities on Page 44

SPECIAL NOTICE TO SUBSCRIBERS

We have received some complaints from subscribers to the effect that Power House is not being delivered. In almost every case investigation has shown that our friends have changed their addresses and have NOT notified us.

Let every subscriber look at the address on the label of this issue of Power House, and, if it is not correct, please fill in and mail to us the following:

Name .....

Old Address .....

Change to

New Address .....

Occupation .....

Address "Power House"
143 University Ave. Toronto, Ont.

Bronze to Bronze **DART** At the Joints

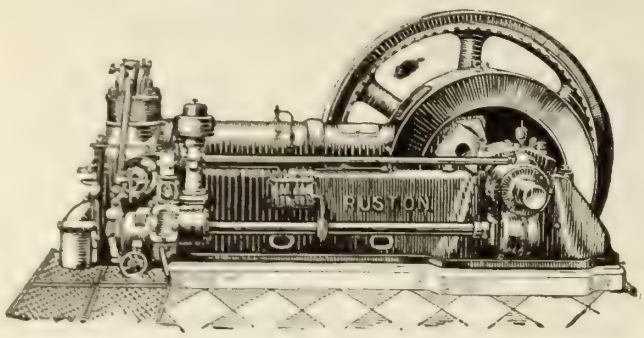
UNION PIPE COUPLINGS

Are Positively Non-corrosive at the Joints

Your dealer has them. Manufactured by Dart Union Company, Limited, Toronto

RUSTON & HORNSBY LTD.

LINCOLN, ENGLAND



CRUDE OIL ENGINE

Simple and easy to operate. Very economical.

May we send you catalogue?

Paterson Engineering Co. Ltd.

LONDON, ENGLAND

Feed Water Meters
Water Softeners
Oil Eliminators
Chlorine Feed Apparatus

Heenan & Froude Ltd.

WORCESTER, ENGLAND

Air Coolers for Turbines, etc.
Oil Coolers

AGENTS:

LAURIE & LAMB, Board of Trade Bldg., MONTREAL

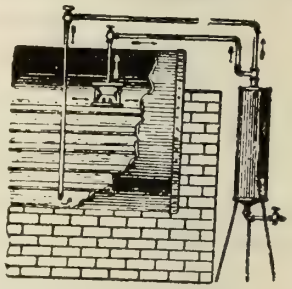
Turner's Automatic Boiler-Cleaner Solves the Problem

Sediment, Incrustation or Scale-Forming Tendencies of Feed-Water Eliminated by using TURNER'S PATENTED SKIMMER

Boiler Compounds, Water-Softening, or Combined Heater-Filters cannot accomplish what is possible with our skimmers.

We guarantee satisfaction when installed according to our requirements.

Write for free booklet explaining action of impurities in feed-water and how the skimmer eliminates same continuously and entirely.



C. B. TURNER & CO., Office: 894 Bathurst St. Works: 58 Peter St. **TORONTO**

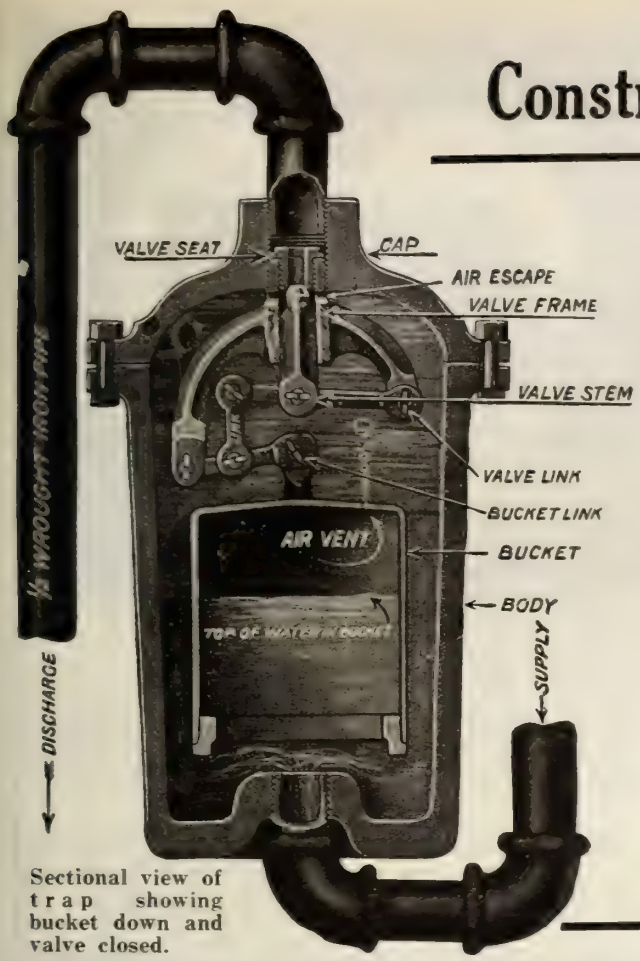
When answering this advt. please mention "Power House."

A Striking Message

A STRIKING message to manufacturers of power-house equipment is derived from a letter written by a "Power House" reader in reply to a request for a criticism of the paper and for suggestions as to how it could be improved. Here is the letter:

"I believe Power House compares favorably with other power-house journals in many respects. One department I would like to see at least three times its present size is the selling section. Many of the ads. are from all-American U.S. firms but there must be many others, some of them with Canadian branches and agencies, who do not carry an advertisement in Power House. **This is a mistake on their part,** but for all I know to the contrary it may be due to the lack of energy on the part of the Power House ad. manager in getting after them. **It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages SO MUCH AS ON THE ADVERTISEMENT PAGES."**

Constructed to Save You Trouble



Sectional view of trap showing bucket down and valve closed.

The ARMSTRONG Steam Trap

was originally developed for use on the individual dryers or units of a paper machine, where the conditions are most severe and require a small trap of large capacity; a trap that will not become air bound, and will require practically no attention.

The Armstrong successfully met the requirements of paper makers, and since has been applied to practically all other fields with equal success.

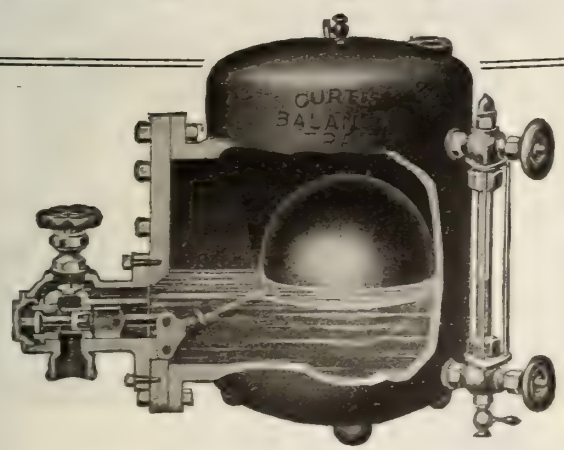
The Armstrong Steam Trap has won considerable popularity because of its dependability, compactness and low cost. It has many exclusive features and embodies a principle which precludes the possibility of passing steam or of giving trouble. It is a trap mechanically simple, carefully constructed of the best materials and conscientiously backed by the manufacturer.

THE ARTHUR S. LEITCH CO., LIMITED

Sales Engineers

1001-2 Kent Bldg. - Toronto

Curtis Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on high and low pressures.

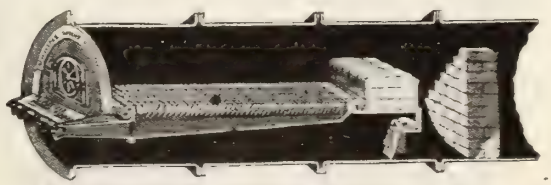
Write for our No. 50 Catalog of Curtis Engineering Specialties.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, 14, Mass.

Agencies: 180 Washington St., New York City. 318 West Washington St., Chicago, Ill.

The TURBINE Furnace



Burns Any Fuel

Burns coal slack, coke dust or any low-grade fuel with all the advantages of forced draft. Wherever installed it is saving plant owners hundreds of dollars. More than 1,100 giving satisfactory service in British plants.

The Turbine is easy to install and is equally effective for either externally or internally fired boilers.

WRITE FOR FULL PARTICULARS

Manufactured by the Turbine Furnace Co., Limited, London, England

Sole Canadian Agent:

PERCY A. GOEPEL

525 Pender Street West, Vancouver

Columbia Recording Thermometers

Chart Changing Made Easy

Among the many exclusive features of S. & B. Recording Thermometers the ingenious Pen Arm stands out as an important innovation in recorder construction.

The Chart Changing operation on Recorders equipped with the ordinary rigid pen arm is a difficult one. The pen arm must be held away from the chart with one hand while the chart is changed. This is not only awkward but often causes a spilling of ink (perhaps spoiling the chart) and also strains the pen arm.

The special construction of the S. & B. Pen Arm and Ink Container makes chart changing the simplest operation. The writing arm is merely lifted from its supporting adjusting disc and allowed to drop to one side. This leaves both hands free to handle the chart. The exclusive S. & B. Ink Container is so constructed that there is no danger of ink spilling.

The many inquiries we are receiving leads us to believe we can best meet the general desire for definite information by dealing with the S. & B. exclusive features one at a time. This is the first —others will appear in the following issues of this journal. Look for them, they will interest you.

THE Schaeffer & Budenberg MFG. CO.

(of Brooklyn, N. Y.)

Makers of Columbia Recording Thermometers and Gauges with TIME PUNCH

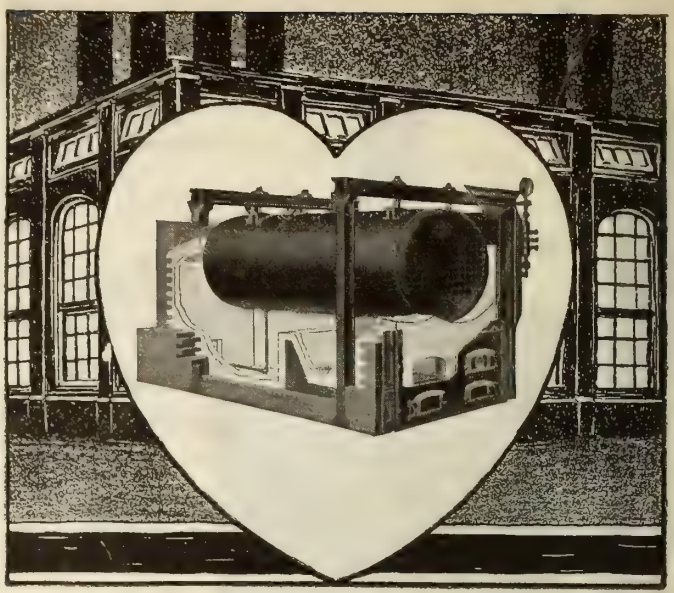
TORONTO BRANCH

67-69 Frederick St.

(Phone: Main 2578)

MONTREAL AGENTS:

Patton Mfg., Co., - 284 Beaver Hall Hill



The Heart of Your Plant is the Boiler Fire Box

Insure long, efficient service of this vital organ by using only monolithic walls, arches and baffles made in one seamless piece with Betson's Plastic Fire Brick. Eliminate separate brick, blocks, tile and mortar joints. Learn how to cut repair bills 50%.

Write for booklet.

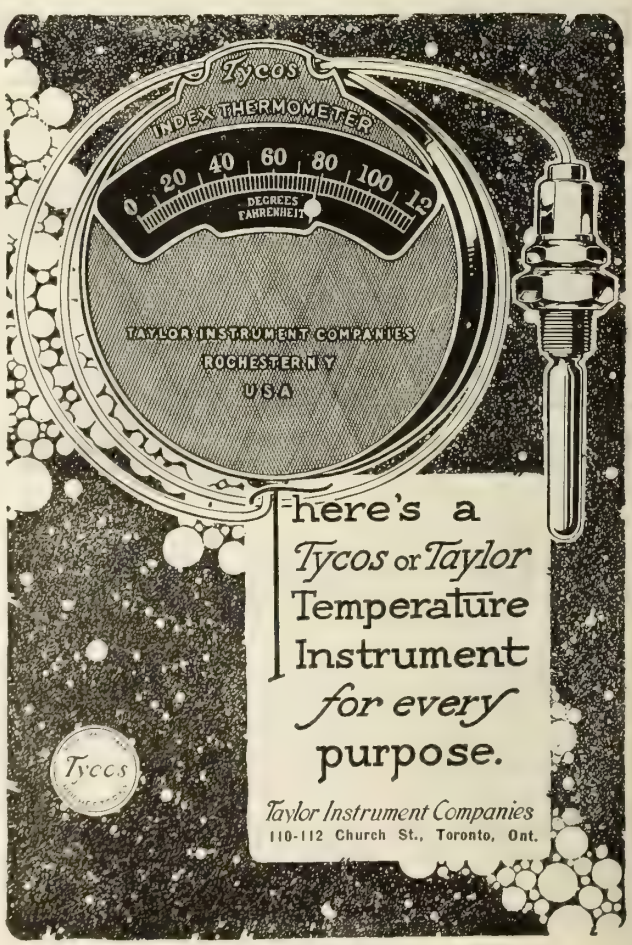
Betson Plastic Fire Brick Co., Inc.

P. O. Box 386-6 Rome, N. Y.

CANADIAN DISTRIBUTORS:

International Chemical Co.

44-6 Lombard St., Toronto, Ont.



Your Forced Draft Is Just As Dependable As Your Fans

Upon the fan depends the efficient and uninterrupted operation of the boiler plant where blowers furnish forced draft.

C S C High Speed Fans insure never-failing service and have demonstrated their worth in power plants throughout the country.

With their self-aligning, spherical seated bearings —machined with extreme accuracy and lined with special babbitt metal—C S C High Speed Fans are built to give long-continued, dependable service under the most severe conditions.

The most important factor in the design of a high speed fan for forced draft is the wheel construction. A distinguishing feature of the wheels of C S C High Speed Fans is the use of annular rings, limiting the width of the blades and giving a tremendous strength with a minimum of weight—a condition most desirable in a wheel revolving at high speed. This construction makes possible the use of driving rings adjacent to the outer ends of the blades, keeping the wheel permanently concentric. No tie rods or tie rod adjustments are used, thereby eliminating possible eccentricity and an unbalanced condition.

The center plate, annular rings and the driving rings are made from solid sheets of steel accurately turned to size. This combined with the fact that the hubs are finished all over, inside and out, insures a perfectly balanced wheel.

CANADIAN SIROCCO COMPANY, LIMITED, WINDSOR, ONT.

BRANCH OFFICES IN ALL PRINCIPAL CITIES

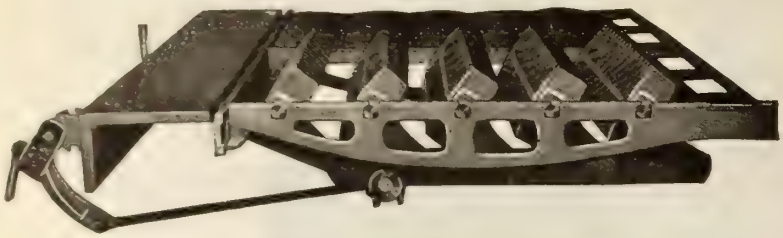
"Sirocco" Products

TRADE MARK

BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

Burn Cheaper Fuel in Your Power House



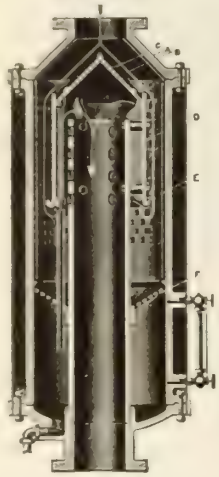
CYCLONE GRATES

have been designed with much care by practical men with many years' experience. The correct proportioning of air space (60%) and underdraught (90%) means not only the elimination of waste but makes it possible to secure maximum heating service when burning any grade of hard or soft coal **or even the screenings of same.** This is one reason why most of the largest concerns in Canada have installed CYCLONE Grates.

Write for our trial proposition.

The Canadian Steam Boiler Equipment Co., Limited
Sole Makers for Canada
20 McGee Street Phone G. 3660 Toronto, Ont.

10,000 Sweet's Separators are serving discriminating steam users around the world.



Half of them sold on repeat orders. This record is backed by authentic tests, copies of which are mailed on application. For live steam mains or exhaust lines made in sizes from 25 pounds in weight to 25,000 pounds.

Read our story before buying.

Sweet's Separators

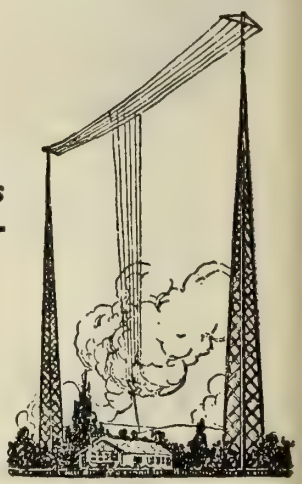
DIRECT SEPARATOR COMPANY
218 South Geddes St. - Syracuse, N.Y.

General Sales Agents

Canadian Fairbanks-Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

Extraordinary Announcement

To Canadian Power Plant Engineers



Radio telephony and telegraphy simply explained at home by mail in twenty lessons.

Complete instructions for wireless communications.

Operators and installation engineers are in great demand the world over at large salaries. Travel without expense.

Our experts will teach you wireless telephony and telegraphy quickly at your home; and we will assist you in obtaining a splendid position when you complete your course.

Learn the Wonders of Radio!
Be Among the First!
Get the Cream!

The greatest opportunity of the age is now offered you. Do not delay.

Any one can learn this fascinating work and the price is small. Payment monthly, if desired. Write at once for our SPECIAL PRICE and terms including all text books and a complete automatic wireless outfit for practice.

Our Branch Tube Receiving Set is guaranteed for 100 miles. Price complete delivered to your home—**$125.00.**

The Joseph G. Branch Institute of Engineering
BRANCH BUILDING
3917 Grand Boulevard, Chicago, Ill.

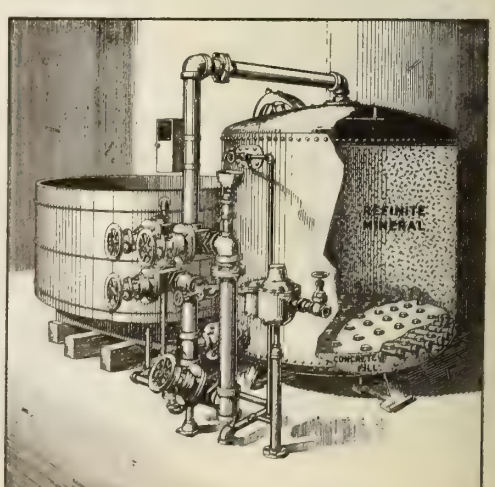
REFINITE makes water fit to wash with and good to drink.

REFINITE We have the solution, if you have the problem.

REFINITE Systems of different sizes and for all purposes.

REFINITE not only softens but purifies water.

REFINITE makes a uniform product possible.

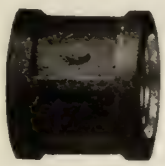


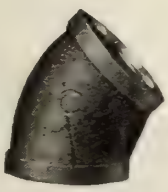
REFINITE
TRADE MARK
Nature's Water Softener
Copyright 1911—The Refinite Co.

THE REFINITE COMPANY OF CANADA, LIMITED
Room 305, Continental Life Bldg.
TORONTO

CRANE FITTINGS

MALLEABLE —————— CAST IRON





Make Tight Joints

Our patterns for malleable and cast iron fittings include all the necessary sizes and shapes to meet all requirements.

CRANE
LIMITED

Manufacturers of Valves, Fittings and Piping Equipment and Distributors of Pipe, Plumbing and Heating Supplies.

Branches and Warehouses:
HALIFAX, OTTAWA, TORONTO, HAMILTON, LONDON, WINNIPEG, REGINA, CALGARY, VANCOUVER.

Sales Offices:
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CRANE
LIMITED
HEAD OFFICE & WORKS
1280 ST PATRICK STREET
MONTREAL

CRANE-BENNETT
LIMITED
Head Office and Warehouse:
LONDON, ENGLAND,

Sales Offices:
BIRMINGHAM, CARDIFF, GLASGOW, LEEDS, MANCHESTER,

14

Ready To-day--MacLean's Mid-Summer

All Fiction Number

BY WAY of an innovation, the August 1st issue of MACLEAN'S MAGAZINE has been produced as a Mid-Summer All-Fiction Number. The cover is by C. H. Taffs, the noted English artist who made such a hit with the cover of our January 1st issue this year.

There will be the usual Review of Reviews section, the Woman's Department, the Scoutmasters' and the Financial Departments; but, for this one issue, there will be no other serious original articles.

The chief feature of this issue will be a 42,000 word novel,

"THE JADE GOD," by Alan Sullivan

Never before has a complete novel been published in one issue of a Canadian periodical. In fact, there are few magazines in United States which have ever done it. There will be ten full pages of this novel at the front, well illustrated, as well as a generous turnover at the back of the magazine. In book form this one novel would sell for $1.75.

$1.75 Novel — **August 1st** — For Only 20c

Other big fiction features in the August 1st issue include—

"CHEESE," by Henry Holt, is the story of a business man who has spent his life manufacturing cheese—and made a big success of it. He suddenly gives way to an impulse which his wife cannot curb and which leads him through many ventures, New York, Paris, Monte Carlo—in all of which he learns to "take a chance."

"THE PINK PAGODA" is from the pen of Isabel Ecclestone McKay, that charming Canadian novelist who looks out on the world from her comfortable Vancouver home and who has achieved such a recent success with her book, "The Window Gazer."

"THE GUEST OF TRADITION" is a newspaper yarn by J. L. Rutledge. George Wilcox was a tradition around the old "Examiner" office and whenever cub reporters came on the staff they were urged to write like Wilcox. But Wilcox met a dainty little bit of femininity from the stage and the criss-crossing of their lives, and the wrecking of his ambition, are woven into an extraordinarily gripping tale.

"PER AGREEMENT" is by Archie McKishnie and is a mystery story told in this Canadian writer's best vein.

"HOOKS AND EYES," by Lloyd Roberts. Something is bound to happen when a bunch of New York chorus girls decide to venture into the Canadian wilds during the off-season (speaking theatrically), in order to get into condition for the rigors of their winter performances.

"THE TRYST OF THE WHITE LADY," by L. M. Montgomery. This is a delightful little love story with a very unusual turn to it, a story which measures up to the high standard which you expect from the author of "Anne of Green Gables."

"OVINGTON'S BANK," by Stanley J. Weyman. This is the next to the concluding instalment of this most popular serial.

On Sale To-day 20c

MACLEAN'S

"CANADA'S NATIONAL MAGAZINE"

At News dealers 20c

Get Your Copy To-day

or Send $3.00 for a Year's Subscription to MACLEAN'S MAGAZINE, 143-153 University Avenue, Toronto

Fig. 106
JENKINS BRASS GLOBE VALVE
(Standard Pattern)

Suitable for 150 pounds working steam pressure or 250 pounds working water pressure.

These Are Genuine Jenkins Valves

Note the name "Jenkins" inside the diamond mark on the body and the Jenkins signature beneath.

That's the sign that assures you lasting free-from-trouble valve service. It's the stamp of the genuine Jenkins—a mark it will pay you to look for when buying valves.

The line of Genuine Jenkins is very complete—valves in brass, iron and cast steel to meet every service requirement.

Fully pictured and described in Catalog No. 8—Free on request.

JENKINS
RAPID ACTION VALVE

Can be opened instantly.
Stays open automatically.
Stops water waste.
Saves time. Fitted with Jenkins renewable composition disc.

Fig. 720

JENKINS BROS. LIMITED

103 St. Remi St., Montreal

Toronto Winnipeg Vancouver

European Branch--6 Great Queen St., Kingsway, London, W. C. 2., England

Jenkins Valves

SINCE 1864

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

Study "POWER HOUSE" Advertisements

AIR COCKS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

AIR COMPRESSORS
Arthur S. Leitch Co., Ltd., Toronto.
American Steam Pump Co., Battle Creek, Mich.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Laurie, Lamb, Montreal.
MacGovern & Co., Inc., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton
Taylor Instrument Co., Toronto, Ont.

AIR METERS
Bailey Meter Co

ALLOYS, BRASS AND COPPER
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., Ltd., The.
Northern Electric Co., Ltd., Montreal.

AMMETERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.

AMMONIA PLANT EQUIPMENT
Can. Fairbanks-Morse Co., Ltd., Montreal
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.
Under-feed Stoker Co. of Canada, Ltd. Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

ASBESTOS ROOFING
Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
Baldam Asbestos (Canada) Co., Toronto.
Can. Johns-Manville Co., Ltd., Toronto.
Durabla Mfg. Co., New York, N. Y.
Garlock Packing Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Pratt & Cady Co., Inc., Hartford, Conn.
Jamieson Cold Storage Door Co., Hagerstown, Md

AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co., Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
Under-feed Stoker Co. of Canada, Ltd., Toronto, Ont.

BABBITT AND ANTI-FRICTION METAL
Can. Fairbanks-Morse Co., Ltd., Montreal
Magnolia Metal Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BACK PRESSURE RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

BALLCOCKS
Jas Morrison Brass Mfg. Co., Toronto.
D'Este Co., Julian, Boston, Mass.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Boiler Setting Co., Toronto.

BAROMETERS
Taylor Instrument Co., Toronto, Ont

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co., Ltd.
Toronto.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Kingsbury Machine Works, Frankford, Philadelphia, Pa.
Canadian Sirocco Company, Ltd., Windsor, Ont.
Northern Electric Co., Ltd., Montreal.

BEARING METALS
Beveridge Supply Co., Montreal.

BELT CEMENT
D. K. McLaren, Ltd., Montreal, Que.

BELLS
Jas Morrison Brass Mfg. Co., Toronto

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
R. C. Miller Oil & Supply Co. Ltd., Montreal.

BELT DRESSING
D. K. McLaren, Ltd., Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Shell Bar Boico Supply, Ltd., Toronto.

BELT FASTENERS
D. K. McLaren Ltd., Montreal, Que.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. McLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELT HOOKS
D. K. McLaren Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. McLaren Co., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
D. K. McLaren Ltd., Montreal, Que.

BELT LACING MACHINES
D. K. McLaren Ltd., Montreal, Que.

BELTING LINK
D. K. McLaren Ltd., Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont
D. K. McLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Ltd.

ARCHES
Can. Fairbanks-Morse Co., Ltd., Montreal

BELTING, FABRIC
D. K. McLaren Ltd., Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Limited, Toronto.
D. K. McLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, STITCHED COTTON
D. K. McLaren, Ltd., Montreal, Que.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BELTING, SOLID WOVEN
D. K. MacLaren Ltd., Montreal.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co, W. R., Toronto

BLOWERS, CENTRIFUGAL
The Mason Regulator & Eng., Co., Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty Co., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINE
Canadian Sirocco Co., Ltd., Windsor, Ont.
Kingsbury Machine Works, Frankford, Philadelphia, Pa.
The Mason Regulator & Engine Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

CORD CLOTHING
D. K. McLaren Ltd., Montreal, Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd. Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply Ltd., Toronto.

BOILER COVERINGS
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BOILER CLEANING EXTRACT
R. C. Miller Oil & Supply Co., Ltd., Montreal.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Sexton Boiler Setting Co., W. A., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Beveridge Supply Co. Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y
Sexton Boiler Setting Co., W.R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCullough Co., Galt.
Leonard & Sons, Ltd, E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd, Toronto.
Gelinas & Pennock, Reg'd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Mason Regulator & Eng. Co., Montreal.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co. Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Leonard & Sons Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren, Ltd., Montreal, Que.

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford.

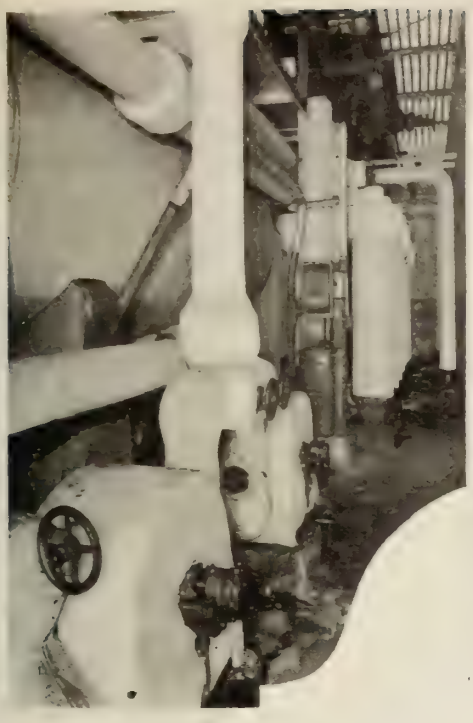
CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.



Brine pumps, tanks, coolers and pipe connections covered with canvas-jacketed Nonpareil Cork Covering. Power plant in the General Motors Building, Detroit, Mich.

For Pipes and Fittings

IT IS not just the lines that have to be insulated. All low temperature equipment needs the protection afforded by Nonpareil Cork Covering and Lags. And all such equipment can be insulated with Nonpareil Covering. Look at the variety of apparatus in this picture and note how completely every piece of it that does not have to be left accessible is encased in an unbroken protective covering.

Nonpareil Cork Covering is made in accurately molded sections for pipes of ordinary sizes and for all screwed and flanged fittings in general use. For the larger pipes and fittings and for brine coolers and tanks, pumps, traps, separators and other irregular surfaces, beveled lags and discs are so readily adaptable that there is no excuse for leaving any low temperature surface in contact with the warmer air. In a single year, Nonpareil Cork Covering will more than pay for itself with the refrigeration it saves.

Nonpareil Cork Covering is made of pure cork granules, compressed in molds and baked to a uniform quality. Its natural gum, its mineral rubber finish, inside and out, and Nonpareil Waterproof Cement in the joints protect it from any possibility of moisture absorption.

Estimates of the insulation needed to protect your equipment will be supplied without obligation. Write for a sample and complete information.

Armstrong Cork & Insulation Co., Ltd.

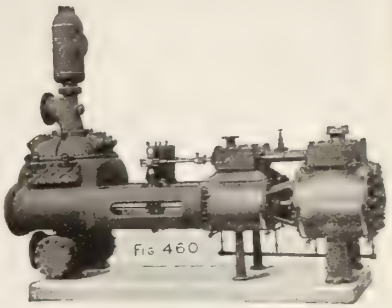
503 McGill Building, Montreal, Que., Can.

11 Brant Street, Toronto, Ont., Can.

Nonpareil Cork Covering

For All Cold Lines

STEAM DRIVEN **DUPLEX PUMPS** POWER DRIVEN



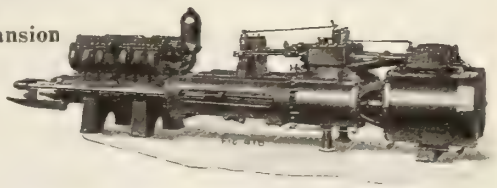
How many Sundays and holidays has your engineer spent in the plant tinkering with a pump so it will be ready to start and perform its part in the cycle of plant operation? Try a McGowan and be convinced that it is the best.

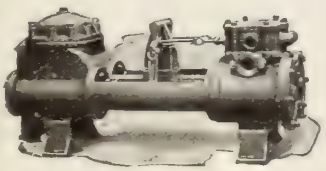
SIMPLE
DUPLEX
STEAM
POWER

Condensing

Non-Condensing

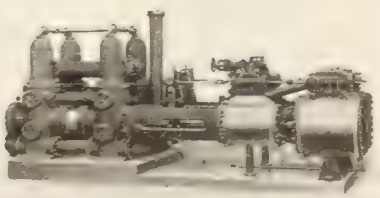
Compound
Triple Expansion





Pressure Patterns
Packed Piston
Semi-Corliss
Piston Valve

For All Conditions of Service.



THE JOHN H. McGOWAN CO.
CINCINNATI, OHIO U.S.A.

CHIMNEYS
Arthur S. Leitch Co., Toronto

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J. H. Williams & Co., Brooklyn, N. Y.

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Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
R. C. Miller Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

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Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

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Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Waterous Engine Works Co., Brantford.

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COAL HANDLING MACHINERY
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Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West Toronto.
MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

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York Manufacturing Co., York, Pa.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, ue.
MacGovern & Co., Inc., Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal

CONDUITS
Canadian Johns-Manville Co. Ltd., Toronto

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Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal

CONVEYORS AND EQUIPMENT
Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto
[illegible] Co., Elkhart, Ind
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
[illegible]dy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insultaion Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co. Ltd., Montreal

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach., Co. Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Babcock Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md

DRAFT GAUGES
Schaffer & Budenburg Mfg. Co., Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DRILL RODS
Lincoln Electric Co., of Can. Ltd., Toronto

DROP- FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DRY CLEANING SYSTEMS
Bowser Co., Ltd., S. F., Toronto, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacGovern & Co., Inc., Montreal, Que.

EFFICIENCY ENGINEERING
MacKinnon Steel Co., Sherbrooke, Que.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg., Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
MacGovern & Co., Inc., Montreal, ue.
MacGovern & Co., Inc., New York

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal
B. F. Sturtevant Co., Boston, Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
MacKinnon Steel Co., Ltd., Sherbroke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Pelt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co., of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg., Co., Toronto.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
MacGovern & Co., Inc., Montreal, Que.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
MacGovern & Co., Inc., Montreal, Que.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Robb Engineering Works, Ltd., Montreal.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Prantford.
Robb Engineering Works, Ltd., Montreal.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F. Toronto, Can.

EXHAUST HEADS
Darling Bros., Ltd., Montreal, Que.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N.Y.

EYE BOLTS

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The Montreal.
Sturtevant Co., B. F. Toronto, Can.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Robb Engineering Works, Ltd., Montreal
MacGovern & Co., Inc., Montreal, Que.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meters Co., Montreal, Que.

FEED WATER PURIFIERS
Grover Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.

FILTERS
Grover Corp., East Chicago, Ind.
S. F. Bowser Co., Ltd., Toronto., Ont.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILLING STATION EQUIPMENT
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
S. F. Bowser Co., Ltd., Toronto, Ont.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Grover Corp., East Chicago, Ind.
MacKinnon Steel Co., Ltd., Sherbrooke.
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATION SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Grover Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
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Jamieson Cold Storage Door Co., Hagerstown, Md.

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FITTINGS
Crane Limited, Montreal.

FITTINGS, CAST IRON
Crane Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont

MACLEAN STOKERS

MACLEAN STOKERS

Automatically control the coal feed and air supply to the furnace resulting in complete combustion of every pound of fuel used. Boiler tubes and heating surfaces are clean for longer periods because of the COMPLETE COMBUSTION.

The MACLEAN STOKER **will not violate the smoke regulations of** any city, anywhere!

There are **no grates,** consequently **no siftings!**

Simplicity is the key-note of its construction and the fireman requires no special knowledge of stokers to operate it.

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Limited

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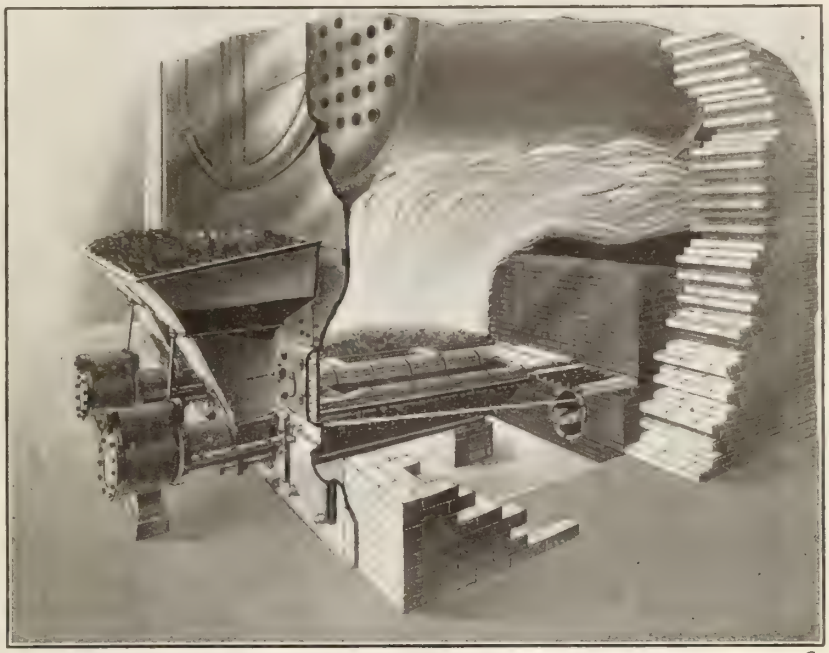
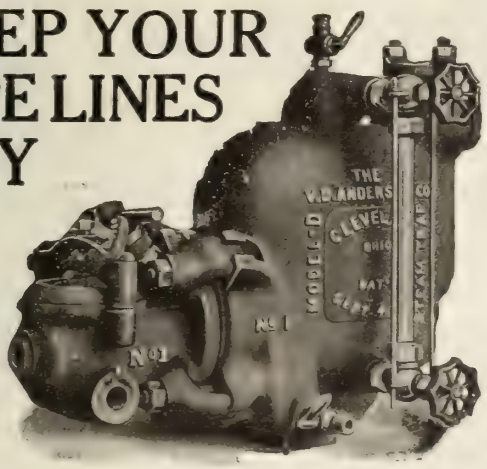


The Coal it Saves
Soon Pays its Cost

KEEP YOUR PIPE LINES DRY



STEAM costs money and in order to obtain the highest efficiency from every square foot of heating surface in your plant it is necessary to distribute dry, hot steam and keep it dry by removing the condensation as fast as it accumulates.

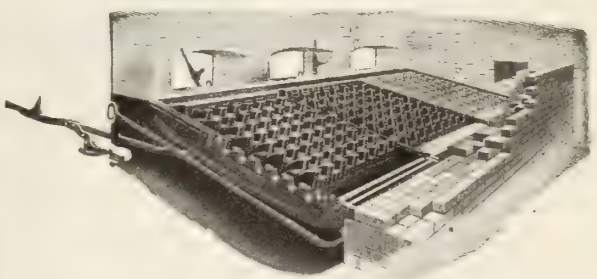
This is just how the **Anderson Model "D" Steam Trap** works for you—it works automatically and continuously. No matter what conditions arise the Anderson Steam Trap stays tight.

Let us send you an interesting catalogue.

THE V. D. ANDERSON CO.
West 96th St., Cleveland, Ohio

CoKal 'Chainless' Stokers

Self Cleaning *Hand Operated*



CoKal stokers can be furnished with or without hopper feeds

EASY TO OPERATE
INCREASE CAPACITY
ELIMINATE SMOKE
HIGH RATINGS
INCREASE EFFICIENCY
COST REASONABLE
SAVE COAL
INCREASE EVAPORATION
GUARANTEE RESULTS
UNIFORM FIRE BED
FIRES ALWAYS CLEAN
SOLVE BOILER PROBLEMS

The Best Hand Stoker Built

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Yarnall-Waring Co., Philadelphia, Pa

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Dominion Flow Metaer Co., Toronto.
R. C. Miller Oil & Supply Co., Ltd., Montreal

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt
Pitley Packing & Flue Brush Mfg. Co., St. Louis, Mo

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Mackinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons, Pittsburg, Pa.

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Jamison Cold Storage Door Co., Hagerstown, Md

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S. F. Bowser Co., Ltd., Toronto, Ont

FUEL OIL SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

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Under-feed Stoker Co. of Canada, Ltd., Toronto.

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International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.

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Babcock & Wilcox, Ltd., Montreal
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, tMch.
Sanford Riley Stoker Co., Worcester, Mass

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Jointless Fire Brick Co., Chicago, Ill.

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Canadian Johns-Manville Co. Ltd., Toronto
Johns-Pratt Co., The, Hartford, Conn.

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Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.

GAS METERS
Bailey Meter Co

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Canadian JohnsManville Co Ltd., Toronto
Can. Steam Boiler Equip. Co., Toronto
Durabla Mfg. Co., New York, N.Y
Frick Co., Waynesboro Franklin Co., Pa
Garlock Packing Co., Hamilton, Ont
R. C. Miller Oil & Supply Co., Ltd Montreal

GASKETS, LEAD, COPPER AND LEATHER
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GAS ANALYSIS CO-2
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S. F. Bowser Co., Ltd., Toronto, Ont.

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Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GAUGE COCKS, STANDARDS AND EXTRA HEAVY
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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.

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Sanford Riley Stoker Co., Worcester, Mass.
Taylor Instrument Co., Toronto, Ont.
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Reliance Gauge Column Co., The, Cleveland, Ohio.
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John Moncreiff, Perth, Scotland.
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Taylor Instrument Co., Toronto, Ont.

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Babcock & Wilcox, Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

GAUGE TESTERS
Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y.

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Babcock & Wilcox, Ltd., Montreal.
Jenkines Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
as. Morrison Brass Mfg., Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Reliance Gauge Column Co., The, Cleveland, Ohio.

GEARS, CUT, WORM, MORTISE
Goldie & McCulloch Co., Galt.
Bovin Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Ssmart-Turner Co., Ltd., Hamilton.

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Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.

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Sturtevant Co., Ltd., B. F., Galt, Ont.

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Smart-Turner Machine Co., Ltd., Hamilton
Darling Bros., Ltd., Montreal, Que.
Leitch Co., Arthur S., Toronto, Ont.
Northern Equipment Co., Erie, Pa.

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Gelinas & Penock, Reg'd. Montreal.
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Canadian Planet Engineering Co., Ltd., Windsor, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Leonard & Sons, E., London, Ont.
Shell Bar Boico Supply Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Victoria Foundry Co., Ltd., Ottawa.
Waterous Engine Works Co., Brantford.
W. R. Sexton Boiler Setting Co., Toronto, Ont.

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Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Shell Bar Boico Supply Ltd., Toronto.
W. R. Sexton Boiler Setting Co., Toronto.

GRAVITY CARRIERS
Can. Link-Belt Co., Toronto, Ont.

GREASE CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Injector Co., Windsor, Ont.

GREASES
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W. R. Sexton Boiler Setting Co., Toronto
R. C. Miller Oil & Supply Co., Ltd., Montreal.

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Mason Regulator & Eng., Co., Ltd., Montreal.
American Steam Gauge & Valve Mfg., Co.
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb, Montreal

HAND PUMPS, OIL AND GASOLINE
S. F. Powser Co., Ltd., Toronto, Ont.

HANDLES, CRANK, MACHINE
Smart-Turner Machine Co., Ltd., Hamilton.

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Canadian General Electric Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Babcock & Wilcox, Ltd., Montreal.
Graver Corp., East Chicago, Ind.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Arthur S. Leitch Co., Ltd., Toronto.
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Graver Corp., East Chicago, Ind.
B. F. Sturtevant Co., Boston, Mass.

HEATERS, METERING
Yarnall-Waring Co., Philadelphia, Pa.

HOISTS, ELECTRIC
Can. Link-Pelt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.

HOIST HOOKS
J. H. Williams & Co., Brooklyn, N.Y.

HOPPERS
Green Engineering Co., East Chicago, Ind.

HOPPERS HOISTING AND CONVEYING
Green Engineering Co., East Chicago, Ind.
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
MacGovern & Co., Inc., Montreal.
Northern Crane Works, Walkerville, Ont.
Waterous Engine Works Co., Brantford.

MACHINERY
Garlock Packing Co., Hamilton, Ont.

HOSE, COTTON
Canadian Johns-Manville Co., Ltd., Toronto.

HOSE, RUBBER
Garlock Packing Co., Hamilton, Ont.

HOSE, SUCTION
Gutta Percha & Rubber Co., Limited.

HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber Co., Limited.

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Can. Fairbanks-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.

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MacGovern & Co., Inc., Montreal, Que.

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Linde Can. Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

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Canadian Johns-Manville Co., Ltd., Toronto, Ont.

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Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

INSTRUMENTS, RECORDING
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Yarnall-Warig Co., Philadelphia, Pa.

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Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

INSULATING COMPOUNDS
Johns-Pratt Co., The Hartford, Conn.

INSULATORS
Johns-Pratt Co., The Hartford, Conn.

IRON FILLER
Can. Johns-Manville Co. Ltd., Toronto.

KEROSENE PUMPS, SELF-MEASURING
S. F. Bowser Co., Ltd., Toronto, Ont.

KEROSENE TANKS
S. F. Bowser Co., Ltd., Toronto, Ont.

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R. C. Miller Oil & Supply Co. Ltd., Montreal.
D. K. MacLaren Ltd., Montreal, Que.

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Can. Fairbanks-Morse Co., Ltd. Montreal
Canadian Johns-Manville Co., Ltd., Toronto, Ont.
Jas. Morrison Brass Mfg Co., Toronto.
J. H. Williams & Co., Brooklyn, N.Y.

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Canadian Johns-Manville Co., Ltd. Toronto, Ont.

LEATHER FILLET
D. K. McLaren Ltd., Montreal. Que.

LINK BELTING
Can. Link-Belt Co., Toronto, Ont.,

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Lunkenheimer Co., Cincinnati, Ohio.

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S. F. Bowser Co., Ltd., Toronto, Ont.

LUBRICATING OIL STORAGE SYSTEMS
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LUBRICATORS, CYLINDER CUTTING COMPOUNDS
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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LUBRICATORS, FORCE FEED
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, PLAIN
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

LUBRICATORS, SIGHT FEED AND MACHINERY INSULATION PLAIN ENGINE
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Mueller Mfg., Ltd., The.

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Murhy Iron Work, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass
MacLean Underfeed Stoker Co., Toronto.

MERCURIAL BAROMETERS
Schaeffer & Budenburg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

METERS, F.M.
Canadian General Electric Co., Toronto.
The Bailey Meter Co., Cleveland.
Dominion Flow Meter Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto.

METERS, (OIL KEROSENE, GASOLINE, ETC.)
S. F. Bowser Co., Ltd., Toronto.

MILL AND MINING MACHINERY
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Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

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Gelinas & Pennock, Reg'd. Montreal.
Lincoln Electric Co. of Can. Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., Ltd., B. F., Galt, Ont.

OILS
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E. H. Kellogg & Co., New York.
R. C. Miller Oil & Supply Co., Ltd., Montreal.

OILS, ENGINE
Imperial Oil, Ltd., Toronto.

OILS, QUENCHING
Imperial Oil, Ltd., Toronto.

OIL CUPS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

OIL AND GREASE CUPS
Penberthy Injector Co., Windsor, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

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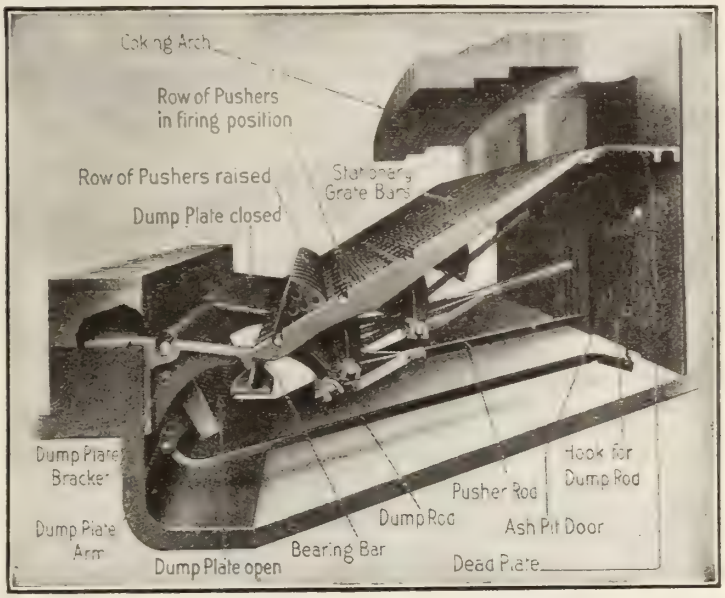
The Mason Regulator & Eng. Co., Ltd.
Superheater Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal
Direct Separator Co., Syracuse, N.Y.
Leitch Co., Arthur S., Toronto, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

DO NOT PASS THIS BY—

An emergency situation in the coal and transportation industries such as we have at present, always brings forcibly to our minds the absolute need of economy and efficiency in the boiler room. Yet these needs are always there if a business is to be really successfully managed. That is why we now suggest that you write us to-day for our booklet on the National Hand Fired Stoker—which effects most important savings — is applicable to your present boilers, using any type of fuel, and affords perfect stoking under all conditions.



Engineering & Machine Works of Canada, Limited

ST. CATHARINES, ONT.

Eastern Sales Offices: Hall Machinery Co., Sherbrooke, and Birks Bldg., Montreal

More or Less Boilers?

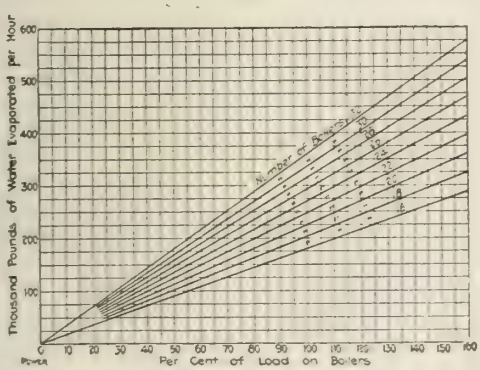


Chart showing number of Boilers to operate.

The VENTURI Meter

"VENTURI" Registered Trade Mark

Answers This Question

At this most critical time in American industry, when careful, far-sighted management is an absolute requirement for any successful business, why not squeeze every bit of energy from your costly fuel used in the boiler plant? The accompanying cut shows a chart devised by a prominent meat-packing concern, to make certain that enough and only enough boilers are used to take care of the load.

The vertical scale is in pounds of water being evaporated as shown by the Venturi Boiler Feed Meter; the horizontal scale is the load in percentage of boiler rating (it having been previously determined at what overload this type of boiler will generate steam with maximum efficiency); the diagonal lines represent the number of boilers in service. The diagram tells immediately whether more or less boilers should be in service for the rate of steaming shown by the Venturi Meter. This is only one of many ways to change the information given by the Venturi Meter into a real money saving which continues as long as the plant is operated.

Do you wish further details?

BUILDERS IRON FOUNDRY, PROVIDENCE, R.I.

Canadian Representatives:

GENERAL SUPPLY CO. OF CANADA, Limited

Ottawa Montreal Winnipeg Vancouver.

ALLEN GENERAL SUPPLIES Limited

Toronto, Ontario

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S. F. Bowser Co., Ltd., Toronto., Ont.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto., Ont.
Lunkenheimer Co., Cincinnati, Ohio

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Beldam Asbestos Canada Co., Toronto
Beveridge Supply Co., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto
Can. Johns-Manville Co., Ltd., Toronto.
Crane Ltd., Montreal.
Crane Ltd., Montreal.
Crane Packing Co., Chicago Ill.
Flexible Metallic Packing Co., Windsor, Ont.
Garlock Packing Co., Hamilton.
Greene, Tweed & Co., New York.
Gutta Percha & Rubber Co., Limited.
Holmes Metallic Packing Co., Wilkesoarre, Pa.
R. C. Miller Oil & Supply Co., Ltd., Montreal
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont
Sarco Co., Inc., New York.
Shell Bar Boico Supply Ltd., Toronto.

PACKING, METALLIC
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont.
S. F. Bowser Co., Ltd., Toronto, Ont

PACKING, OIL
Crane Packing Co., Chicago, Ill.
Flexible Metallic Packing Co., Windsor, Ont

PAINTS
Shell Bar Boico Supply Ltd., Toronto, Ont

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd. Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scfiae & Sons, Pittsburgh, Pa.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa
The Superheater Co., Ltd., Montreal.
Page-Hersey Tubes, Ltd., Toronto, Ont.
Mfg. Co., York, Pa

PIPE COILS, GENERAL PURPOSE
The Superheater Co., Limited, Montreal.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
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Can. Johns-Manville Co., Ltd., Toronto.

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Canada Limited, Montreal
Page-Hersey Tubes, Ltd., Toronto, Ont.

PIPE, SOIL, AND FITTINGS
Crane's Limited, Montreal

PIPE STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Page-Hersey Tubes, Ltd., Toronto, Ont

PIPES, WATER
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Page-Hersey Tubes, Ltd., Toronto, Ont

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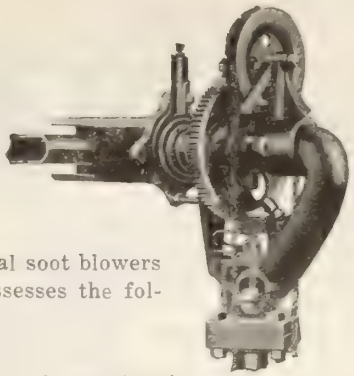

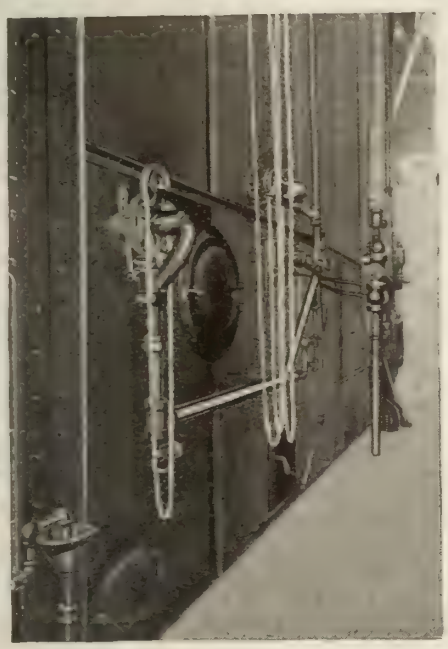

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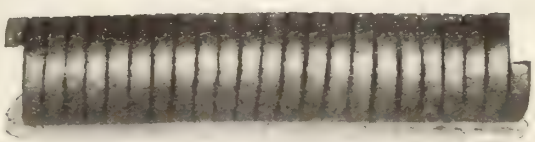

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Lunkenheimer Co., Cincinnati, Ohio.
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Jenkins Bros., Montreal.
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Lunkenheimer Co., Cincinnati, Ohio.
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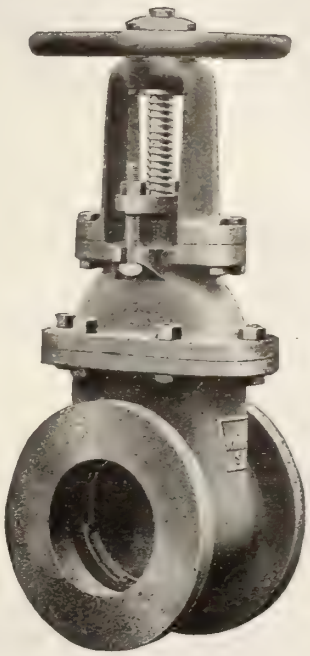

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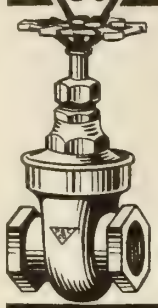

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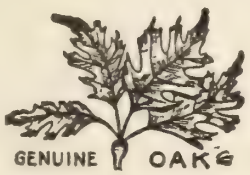

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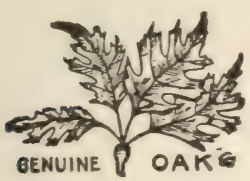

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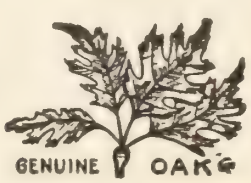

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Vol. XIII.—No. 16. Publication Office, Toronto—August 20, 1920 Published Semi-Monthly Canada, $2; U.S., $2.50 a year

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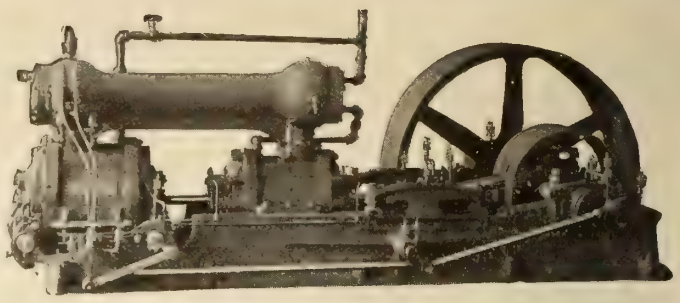

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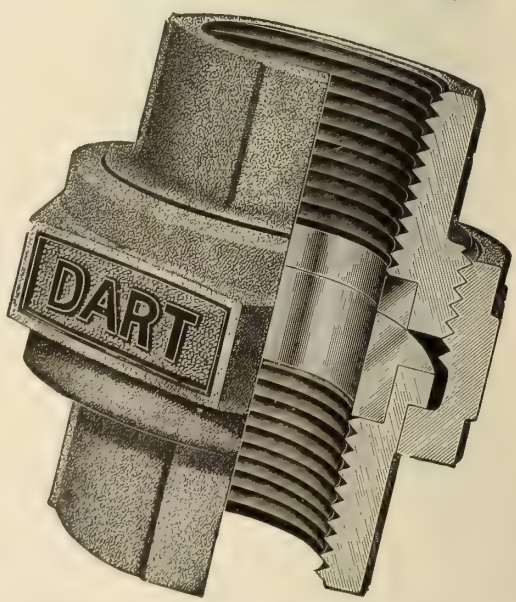
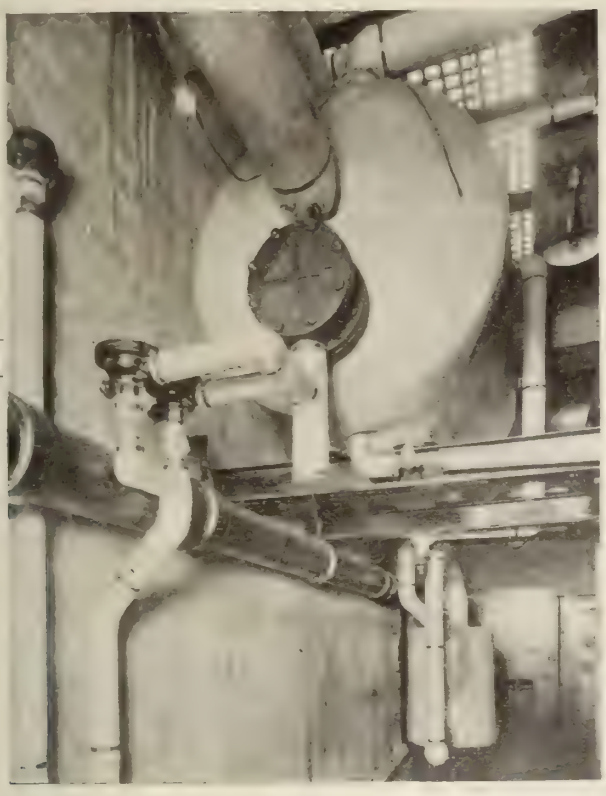


Sims Steam Tube Water Heaters



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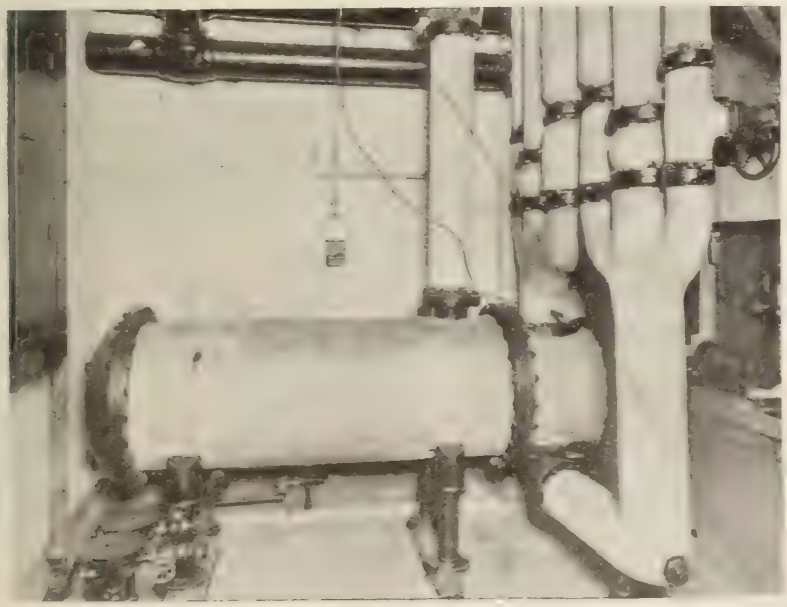

The illustrations show Sims Water Heating Equipment at "Ardwold." Sir John Eaton's residence, Spadina Road, Toronto.

The upper illustration shows a 42 in. x 108 in. Sims No. 6 B.H. Clean E-Z Type Storage Heater for the Domestic Hot Water Supply. The lower illustration shows the Sims Converter, which supplies the swimming pool at "Ardwold."

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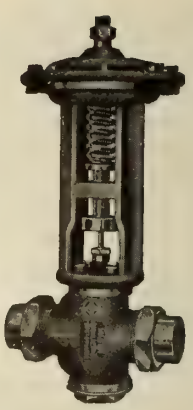
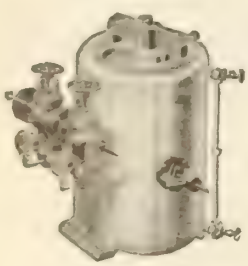


Mason No. 55 Pump Pressure Regulator

Reilly Feed Water Filter and Grease Extractor



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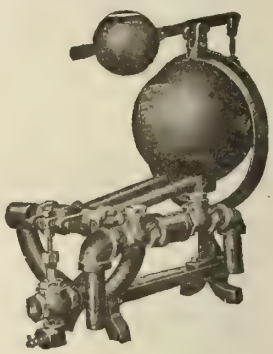

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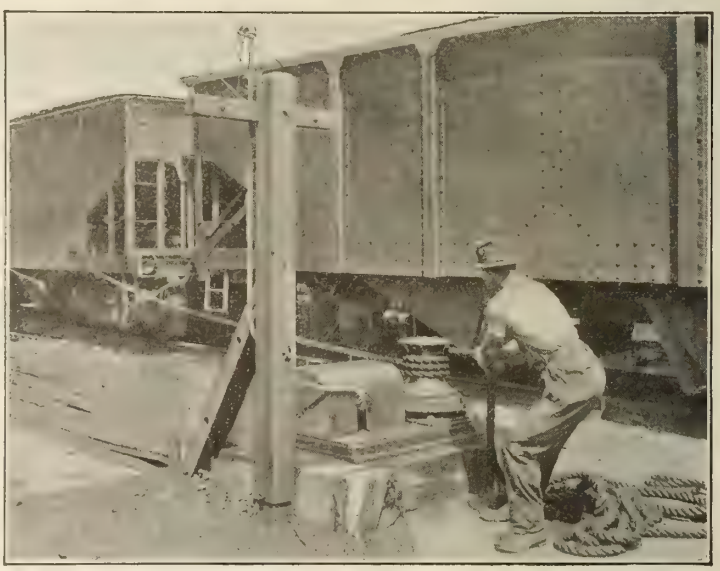
The capacity of the Puller is a Rope Pull of 3,500 pounds at a rope speed of 60 feet a minute.



GETTING ALONG WITHOUT THE SWITCHING LOCOMOTIVE

Furnishes ***Dependable Service***
under all conditions

PUT YOUR PROBLEM UP TO US!

AGENTS: Kelly Powell, Winnipeg; Howard Turnbull, Toronto; Robert Hamilton, Vancouver.

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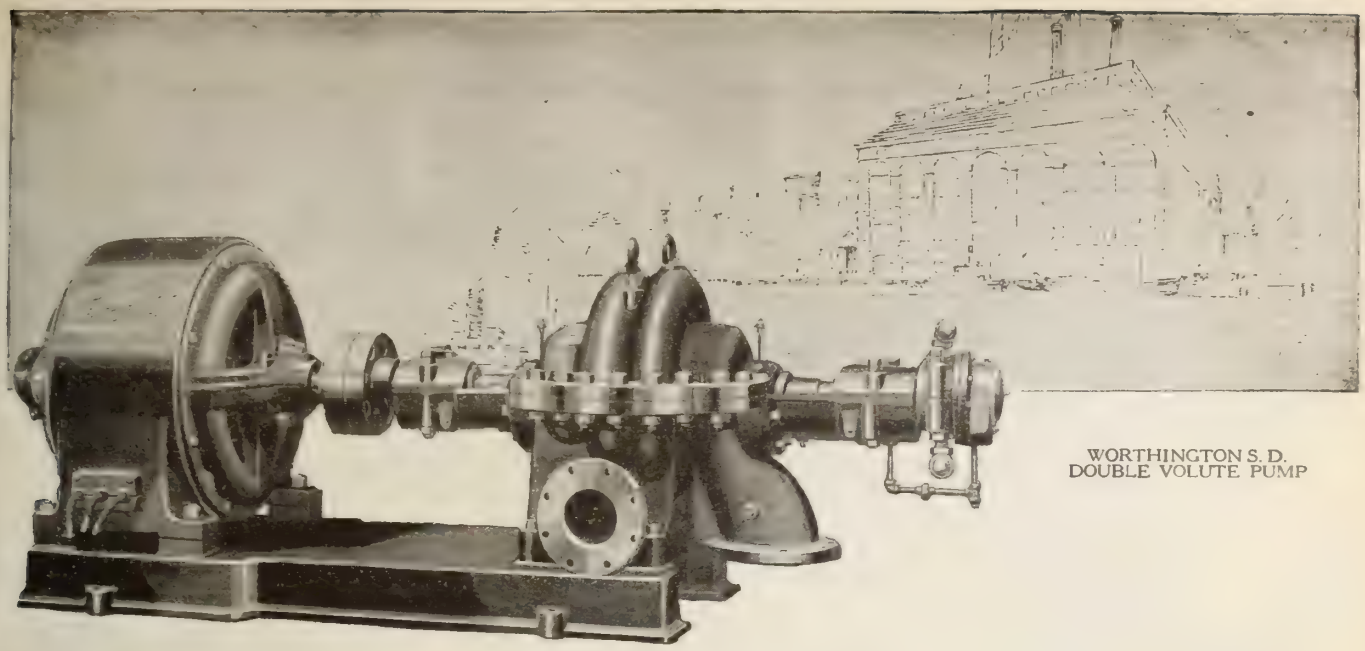

WORTHINGTON S. D.
DOUBLE VOLUTE PUMP

"See our exhibit at the Sixth National Exposition of Chemical Industries, Grand Central Palace, New York, week of September 20th"

—another example of Worthington utility and efficiency

FOR general service in and around coal mines, there is no pump that enjoys a more favorable reputation or renders a more complete pumping service than Worthington S.D. Double Volute Pump.

For fire protection, for heads above single impeller limits, for unwatering mines—this pump can be standardized on, and because parts are interchangeable, repair bills and time losses are reduced to absolute minimum.

Simplicity of design is attained by using the double volute feature which eliminates diffusion rings, and because impellers are "back to back" there is no end thrust. This construction also results in minimum number of slippage points.

Worthington S. D. Double Volute Pump rounds out a full centrifugal pump service and typifies the wonderful 80 years old organization which sponsors it.

Other Worthington Products

Steam, Power, Centrifugal and Water Works Pumps. Meters, Oil Engines, Condensing Machinery, Air Compressors, Vacuum Pumps and Water Wheels.

To further enlarge their service, Worthington have acquired the goodwill and mechanical equipment of the Platt Iron Works, Dayton, Ohio, for manufacturing Oil Mill machinery, Hydraulic Turbines, Feedwater Heaters and High Pressure Air Compressors.

WORTHINGTON PUMP AND MACHINERY CORPORATION
Executive Offices: 115 Broadway, New York City
Branch Offices in 24 Large Cities

W-279.8

PUMPS—COMPRESSORS—CONDENSERS—OIL & GAS ENGINES—METERS—MINING—ROCK CRUSHING & CEMENT MACHINERY

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Deane Works, *Holyoke, Mass.*
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Laidlaw Works, *Cincinnati, Ohio.*

Hazleton Works, *Hazleton, Pa.*

Gas Engine Works, *Cudahy, Wis.*
Power & Mining Works
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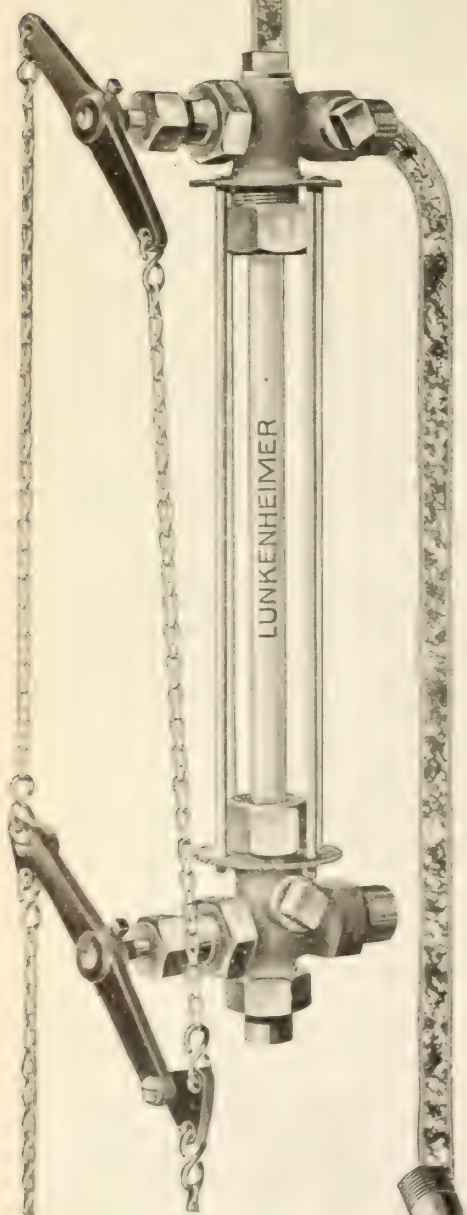
LUNKENHEIMER

WATER GAUGES, GAUGE COCKS AND FUSIBLE PLUGS



Absolute reliability in operation and maximum durability under the most severe operating conditions are the basic factors which govern the manufacture of LUNKENHEIMER WATER GAUGES, GAUGE COCKS, AND FUSIBLE PLUGS. These essential requirements, based on a thorough knowledge of operating conditions; the selection of proper metals for the specific requirements and Lunkenheimer "Quality" workmanship, have established the Lunkenheimer Line as standard for Safety and Economy.

Lunkenheimer WATER GAUGES are reliably accurate. The shut-off valves provide positive control in case of glass breakage and provision is made for the easy renewal of the glass should necessity require. Made in both Automatic and Non-automatic Patterns with Hand Wheel or Cross Lever Control.

Lunkenheimer GAUGE COCKS are substantial, positive in operation, and so constructed that a worn or broken part can easily be replaced. The variety of types made covers every service requirement.

Lunkenheimer FUSIBLE PLUGS are safety devices of merit. The fusible core is pure Banca tin and the Lunkenheimer method of filling the plugs precludes the possibility of chemical change during the process. This insures dependability in service Inside and Outside types in all sizes.

For Safety, Service, and Satisfaction specify LUNKENHEIMER and insist on their installation. Write for descriptive literature.

Distributors of Lunkenheimer Products situated in every commercial center.

THE LUNKENHEIMER CO
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI, U.S.A.

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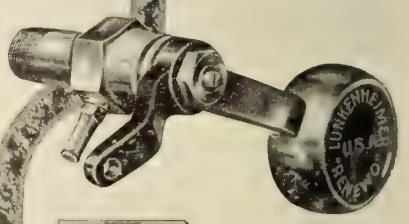

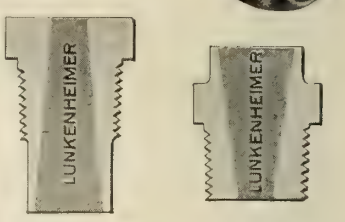

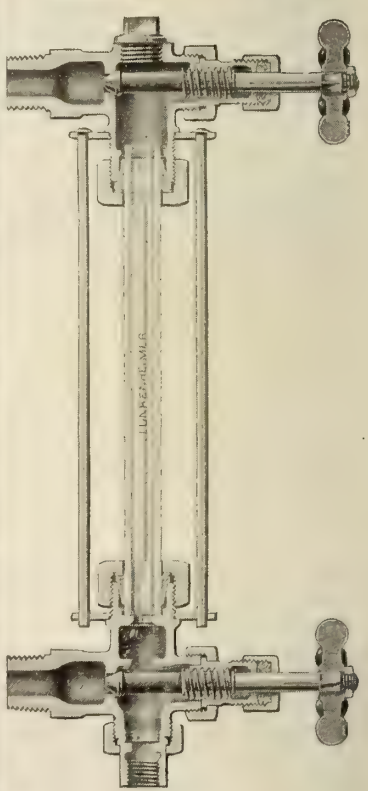

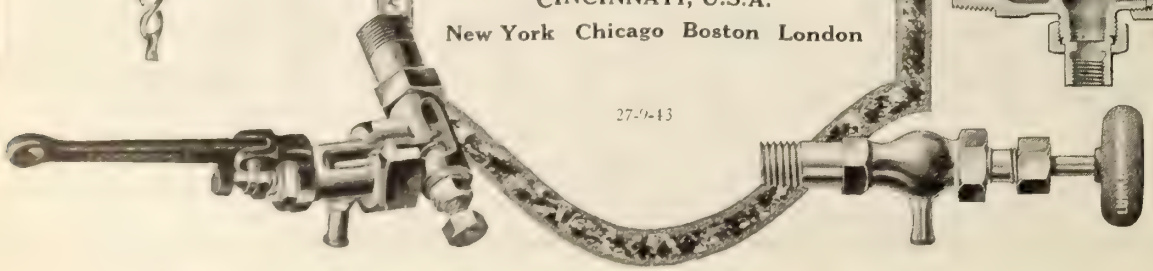

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The World's Standard Sheet Packing

Rainbow Sheet Packing—the *original red sheet*—has given the mechanical world 30 years of unexcelled service under the most exacting conditions.

There are instances of gaskets cut from

Rainbow Sheet Packing

being found in excellent condition after 20 years of dependable service in high pressure steam lines. Insist on the *"Rainbow" Diamond* trade-mark to ensure this dependable service in your *steam* lines.

Our nearest branch will be glad to send you a catalogue on request, and, if you wish, one of our technical experts will gladly help overcome your packing troubles.

Genuine Rainbow Sheet Packing is made in Canada by

DOMINION RUBBER SYSTEM AND ASSOCIATED COMPANIES

Our Dominion Hose, Packing and Industrial Rubber Goods are all the same high standard as Dominion Friction Surface Belting.

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BELTING

Transmission: "Dominion," "Keewatin," "Para."
Conveyor: "Rockproof," "Canadian," "Hiheat."
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Agricultural: "Lumber King," "Star," "Western."
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Air: "Kushion Kover," "Para," "4810 Airtite."
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Suction: "Para," "Star," "Trade."
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Mats, Matting and Flooring, Plumbers' Specialties, Rubber-covered Rolls, Friction Tape, Splicing Compound, Dredging Sleeves, Hard Rubber Goods, Tubing, Rinex Soles, Catspaw Heels, Jar Rubbers, Moulded Goods.

ECONOMY AND EFFICENCY

THIS is the machine that will cure your troubles

Expert Engineers are always at your service
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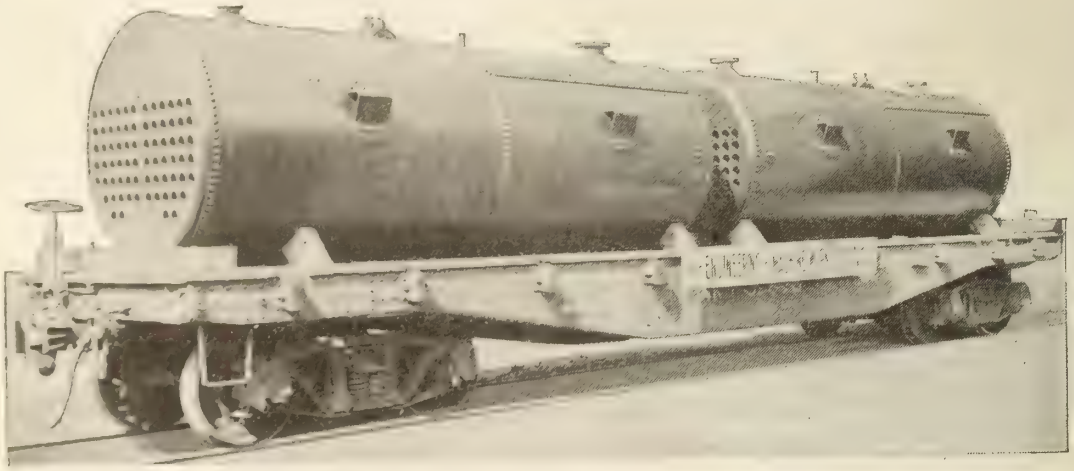
IN THE STEAM PLANT.

Need a New Boiler—Now?

We offer prompt deliveries on following—sizes 125 and 150 lbs. pressure, 72″ x 18′, 72″ x 16′, 66″ x 16′, 66″ x 14′. Our facilities and experience are such that we KNOW you will be pleased with our work.



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LINK-BELT TRAVELING WATER SCREENS

Every Power Plant Engineer Should Have This BOOK

LINK-BELT Traveling Water Intake Screens are a necessity in the modern power plant. They automatically remove all floating trash and debris, and insure a steady supply of clean water to the condensers. Uninterrupted operation is assured at all times regardless of the condition of water supply.

This book gives complete information. It shows what you can accomplish by atomatically screening water before it reaches the condensers. Use the coupon.

CANADIAN LINK-BELT COMPANY, LIMITED
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Please send me a copy of your book No. 352, "Link-Belt Traveling Water Intake Screens".

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Run-of-Mine Coal Through A Jeffrey

Single Roll Crusher

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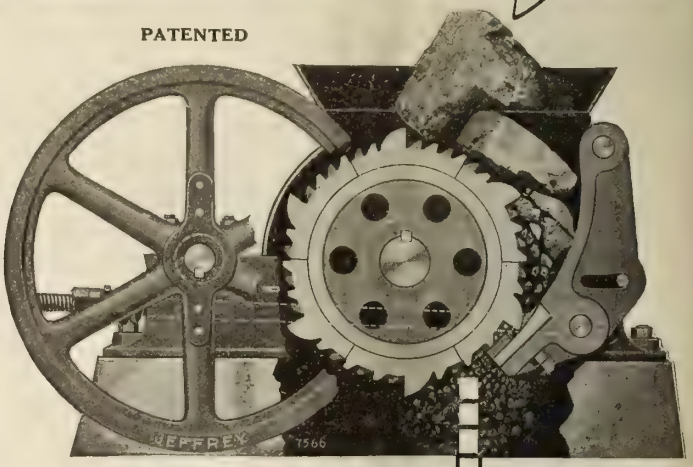
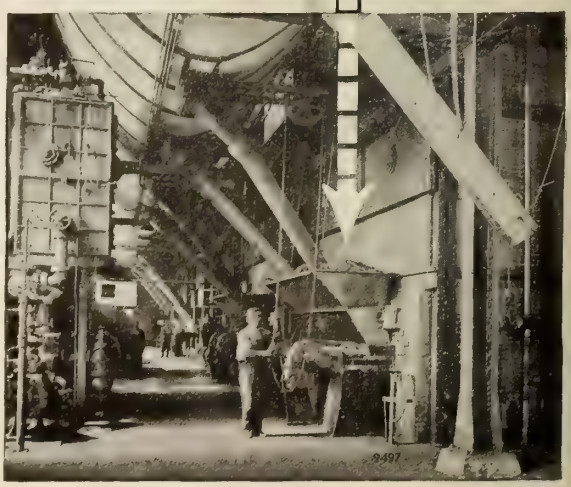




Will Insure Proper Sizes and Quality of Coal For Your Stokers

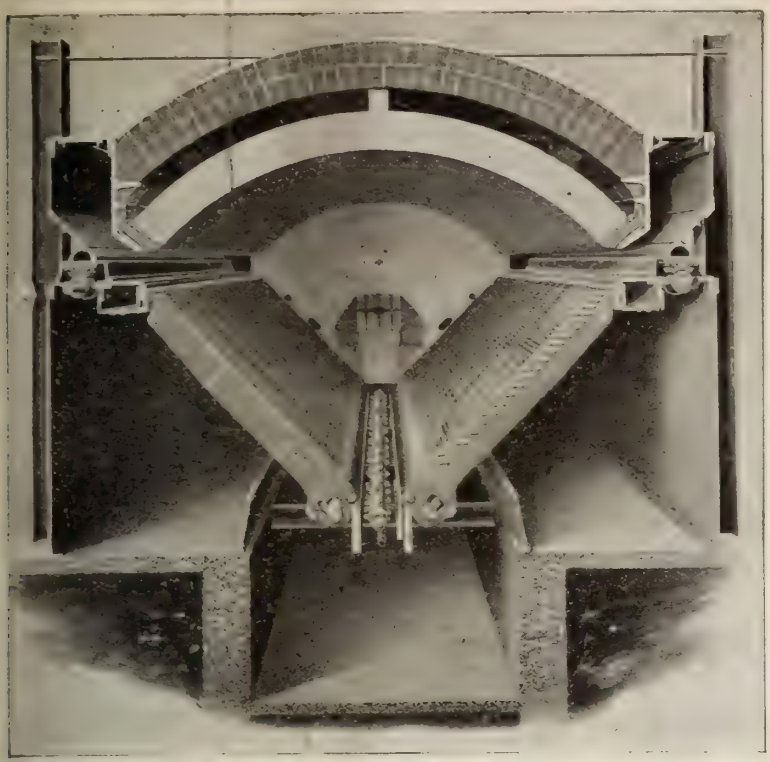
Run-of-Mine or Lump Coal give proper quality, but cannot be used in stokers without crushing. Mine screenings which are of the proper size at times cannot be secured.

The Jeffrey Single Roll Crusher installed at your plant will render it independent of the supply of screenings, and enable you to secure the maximum of stoker efficiency.

Bulletin No. 141-4 should be in the hands of every Manager, Superintendent or Engineer who is responsible for supply of properly sized coal. Send for copy.

The Jeffrey Mfg. Co.

Canadian Branch and Warerooms
MONTREAL



Cross section showing the construction and operation of the Murphy Automatic Furnaces. As the fuel progresses downward the alternate movement of the grates ¾" above and ¾" below the surface of the stationary grates breaks up the fuel bed—prevents avalanching—keeps the grates clinker-free and advances the ash gradually to a point where it is removed by the clinker grinder.

Over 6,000 Boilers

Murphy Furnaces have been relied upon by power users in every field for 44 years to furnish continuous, efficient and economical combustion service—to burn any available fuel—and to automatically remove all ash and refuse.

To-day **over 6,000 boilers** in all sections of the country are fired by

MURPHY
AUTOMATIC
FURNACES

They are being used in practically every line of industry—from hospital to industrial and central station service.

Write for our catalog showing how **Murphy Furnaces** can be installed under any type of boiler.

For information on the Riley Underfeed Stoker for large boilers see advertisement in last issue or send for catalog HR-8.

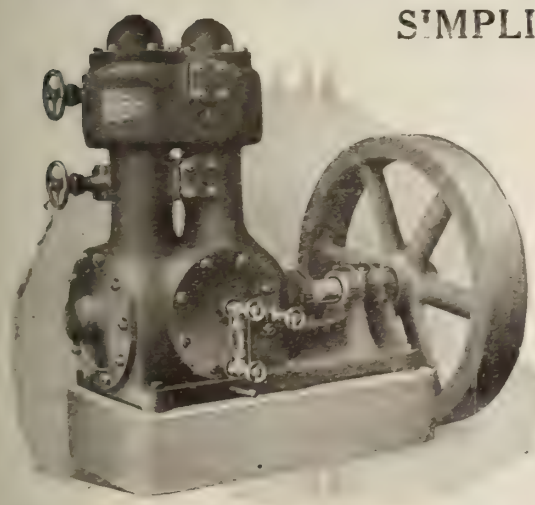
Murphy Iron Works

Detroit, Mich., U.S.A.

BURN ANY FUEL THAT HAS HEAT IN IT

York Enclosed Refrigerating Machines

SIMPLICITY—ECONOMY



After operating one of our Enclosed Machines for several years, one of our customers writes us that he has not spent one cent on it except for oil, and is still using the original charge of ammonia. This is a common experience among users of these Machines.

Simplicity of design and accuracy of construction permit them to be operated successfully by employees who, prior to the installation of these machines, never had any experience in operating one.

If you are finding the present scarcity of ice a burden to your business here is a simple and safe method of relief, and besides MECHANICAL REFRIGERATION pays good dividends on the investment.

Write us for information and prices.

York Manufacturing Company

(ICE-MAKING AND REFRIGERATING MACHINERY EXCLUSIVELY)

YORK, PA., U.S.A.

Canadian Representative:

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WINNIPEG, 88 Lombard St. | TORONTO, Villiers & Munition Sts., Eastern Harbor Terminals | MONTREAL, 324 Craig St. West | CALGARY, 605 Second St.

Gates Refractories, Ltd.

Power Plant Firebricks

Conserve Heat and Cut Coal Bills

Increased boiler capacity and higher fuel economy are two of the advantages that follow the installation of Gates Power Plant Firebricks. They conserve furnace heat and permit a more even and more efficient condition of the fire to be maintained.

Gates Firebricks are easily installed in boiler linings and are so designed that when any part becomes fused a handy man can replace it in half the time it takes to repair a standard fire brick job. There is no possibility of costly air leaks and the many joints that clinkers stick to when ordinary firebrick is used are entirely eliminated. A complete stock of various sizes always on hand. Immediate shipments.

We specialize in all kinds of power plant brickwork. Boiler setting, Furnace building, Oven work and Repair Jobs. Get in touch with us!

Head Office: 382 St. James St., Montreal

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UEHLING
CO2 Recording Equipment CO2
CO2 Recorder for Office of Chief Engineer
CO2 Indicator for mounting on Boiler Front

Keeps B.t.u.'s Out of Flues

Loss of heat up the chimney is the greatest source of fuel waste. Uehling CO_2 Equipment is helping many plants to reduce chimney loss, thereby saving from 10 to 30 per cent of their fuel.

Uehling Features

Permanent CO_2 Record in Engineer's Office

Fireman's CO_2 Guide on Boiler Front

Continuous records (not intermittent)

No Chemical Solutions

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"Combustion and the Cost of Power"

UEHLING INSTRUMENT CO.

Combustion Engineers

2008 EMPIRE BLDG., NEW YORK

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TRADE MARK REGISTERED

STRENGTH—GOODNESS—QUALITY

Performance Facts of Durabla Gasket Material

Tight joints are made and maintained by DURABLA under the following severe services and conditions:

Steam:	275-300 lbs. pressure; 275°-300° superheat.
Oil:	Pressure still joint re-made over 160 times.
Gasoline:	Cylinder heads of gasoline engines and pumps.
Acids:	All acids that can be carried in pipe lines.
Water:	Equally satisfactory with temperature of 40° or 210° F., at any pressure.
Ammonia:	Both absorption and compression systems of refrigeration.
Air:	Air lines and cylinder heads of compressors—all types.

One Standard material for all gasket work—Sold on a Service Basis

DURABLA is sold in sheet or gasket form and the trade mark is stamped all over the material.

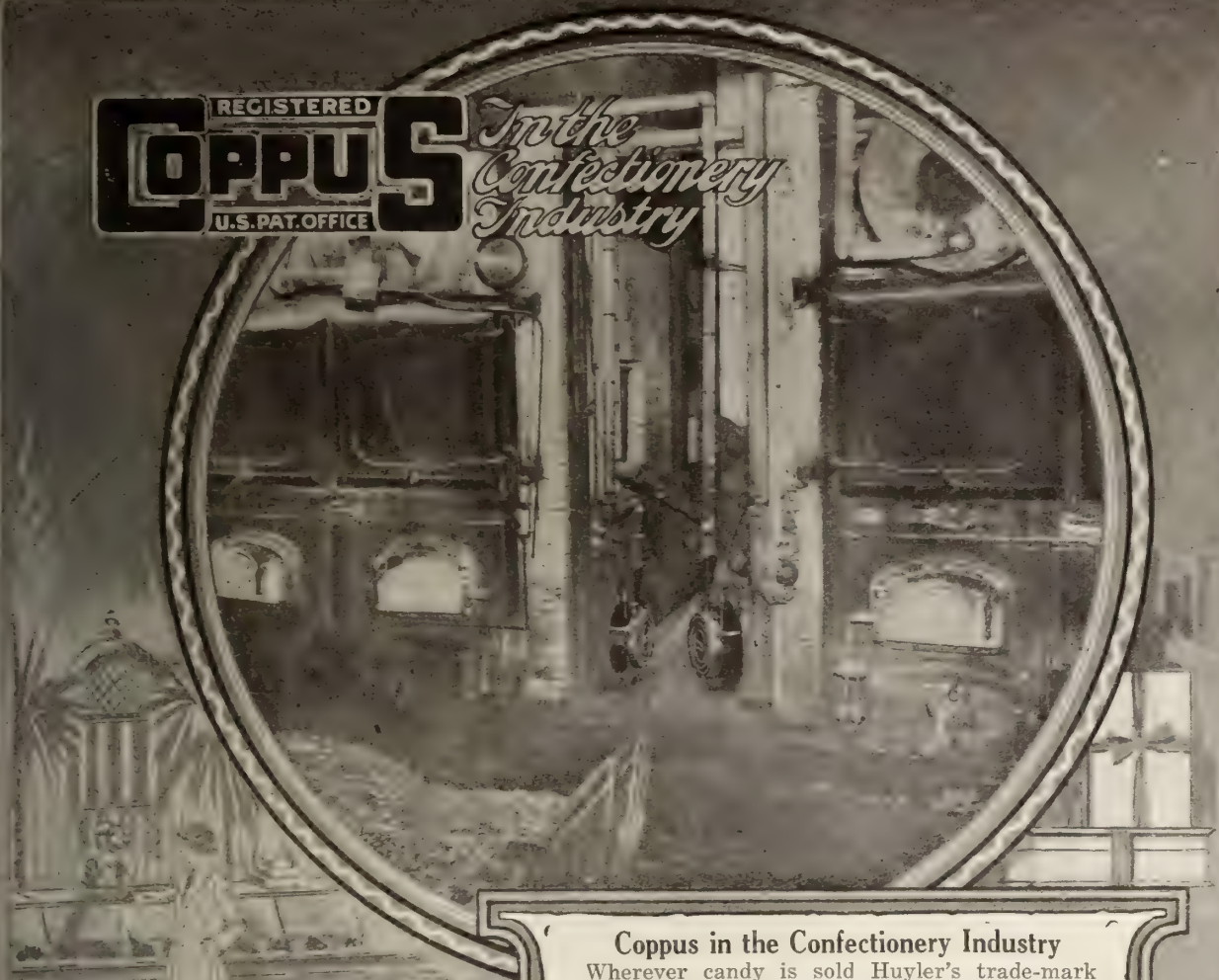
DURABLA MANUFACTURING CO., NEW YORK

Distributors for Canada: The Canadian Fairbanks-Morse Company, Limited

DURABLA

REGISTERED COPPUS U.S. PAT. OFFICE

In the Confectionery Industry



Coppus in the Confectionery Industry

Wherever candy is sold Huyler's trade-mark means quality supreme. Wherever candy is **made**—there is an opportunity for COPPUS Turbo Blowers to save money in power plant operation.

These two 18" Blowers have been economizing time, fuel, and labor in the boiler room of the Huyler's Chocolate Company, 136 East 18th Street, New York City, since July, 1917. They burn inexpensive fuel—keep up full steam pressure—and meet peak loads without extra exertion by the engineer, **quickly, easily, cheaply.**

They can do this better than any other type of blower because of their

Standardized Construction
Rugged Reliability
Economy of Operation

What COPPUS Turbo Blowers are doing in other plants they can do in yours. If you will ask us we will be glad to send you complete information showing just how COPPUS Turbo Blowers can help you secure more power from your present equipment-and greatly increase the efficiency of your power plant.

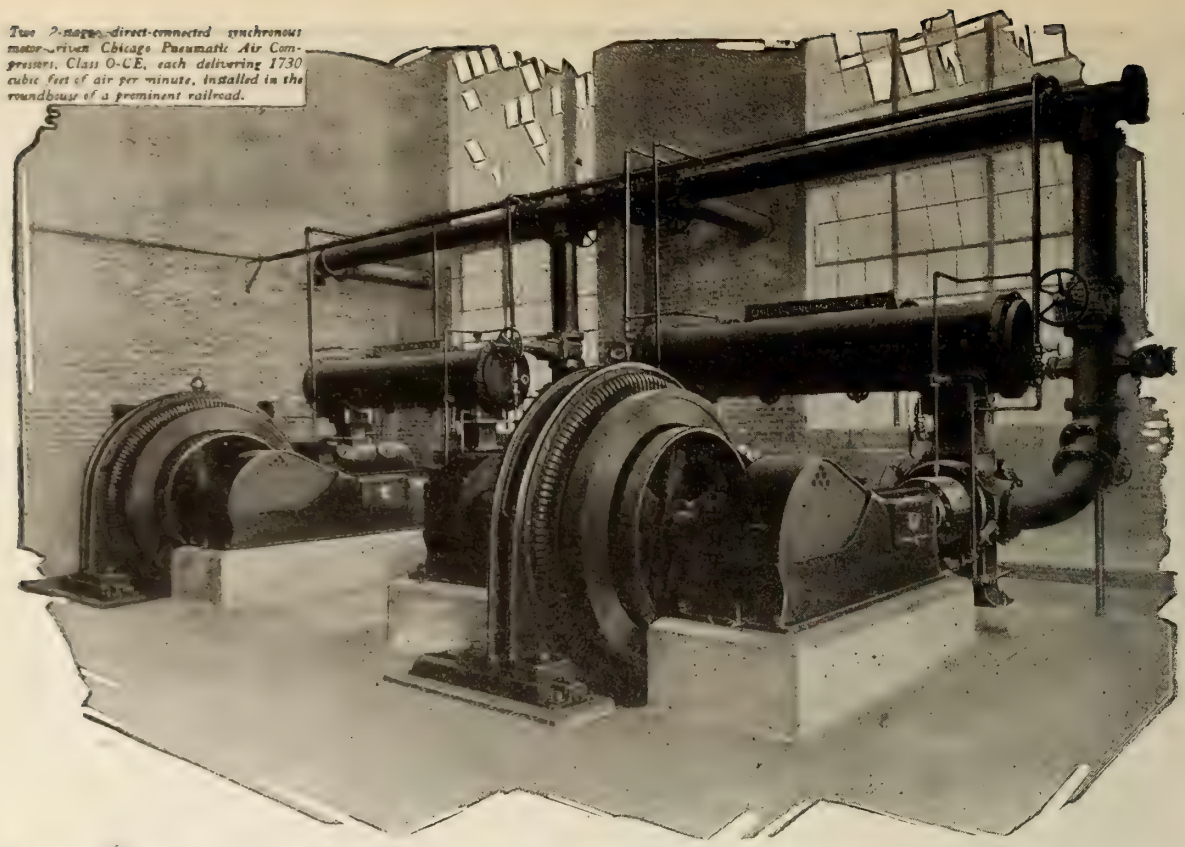
Write for Blower Catalog.

"COPPUS Equipment can Save You Money"

THE COPPUS ENGINEERING & EQUIPMENT CO.
Mfrs. of COPPUS Turbo Feed Pumps and COPPUS Power Turbine
341 Park Ave., Worcester, Mass

Agents for Montreal:—Mason Regulator & Eng. Co., 135 Dagenais Street. Agents for Vancouver:—Frank Darling & Co., Limited, 1142 Homer Street. Agents for Toronto:—Arthur S. Leitch Co., 1001 Kent Building. Agents for Calgary:—W. J. Yeo & Co., 413 McLean Block, Calgary, Alberta.

COPPUS TURBO BLOWER



Two 2-stage, direct-connected synchronous motor-driven Chicago Pneumatic Air Compressors, Class O-CE, each delivering 1730 cubic feet of air per minute, installed in the roundhouse of a prominent railroad.

An unloading system that saves power

DOES your air compressor pull against a vacuum *after unloading?*

Not if it's a Chicago Pneumatic whose unloading system permits the *free passage* of air through valves automatically held open when maximum receiver pressure is reached.

This one Chicago Pneumatic feature saves marked power over compressors in which unloading by choking the inlet pipe means power lost through working against a vacuum after unloading.

Strict power economy *before* and *after* unloading, and economy of floor space, make the direct connected motor-driven compressor illustrated an ideal power unit for—

Railroad shops, shipyards, structural steel plants, cement mills, packing houses, mines, oil refineries, glass manufacturing plants, textile mills, and miscellaneous manufacturing plants.

Know *all* the advantages of Chicago Pneumatics. Have you read Bulletin 400?

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C-55-H

BOYER PNEUMATIC HAMMERS · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · VACUUM PUMPS · PNEUMATIC HOISTS
GIANT OIL AND GAS ENGINES ROCK DRILLS · COAL DRILLS

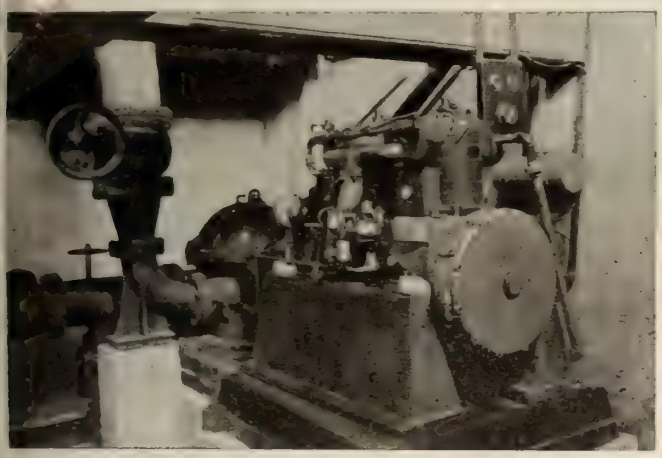
CHICAGO PNEUMATIC

Depend upon that Name

Sterling
THE ENGINE of REFINEMENT
For the finest boats that float

With a monthly fire loss of over $25,000,000 in the U.S.A., the cost of adequate fire protection fades to insignificance.

Many manufacturing plants and municipalities are meeting the need for fire protection economically with a Sterling powered centrifugal pump.

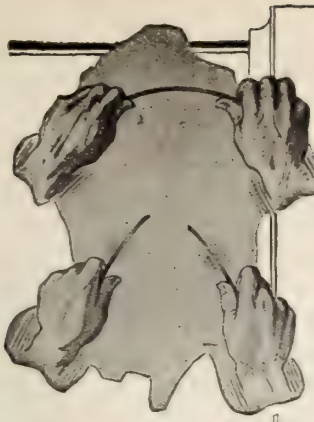


Nominal cost. High Efficiency.

Catalogue on request.

STERLING ENGINE CO., Dept. C-4, Buffalo, N.Y.

12 to 300 H.P. at Speeds up to 1,600 R.P.M.



broken blades are not always poor blades.

Often it's a case of a good saw used in the wrong way. A hack saw may be brittle as glass or flexible as a watch spring, according to the temper of steel, but the temper is only one of the things that go to make good blades.

Starrett Hack Saws are tempered, milled and selected according to the work they are designed to do. That's why they "cut quicker and last longer."

According to the Starrett system of blade selection, there's a saw for every metal. Many saws will cut more than one metal, but no single blade will cut all metals, or even all shapes of the same metal economically.

Starrett Hack Saws plus the Starrett Hack Saw Chart make it easier to cut metal economically. Ask for a copy of Chart CD—and "Hack Saws and Their Use"—both are free.

THE
L. S. STARRETT COMPANY
The World's Greatest Toolmakers
Mfrs. of Hack Saws Unexcelled
ATHOL, MASS.

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Starrett Hack Saws

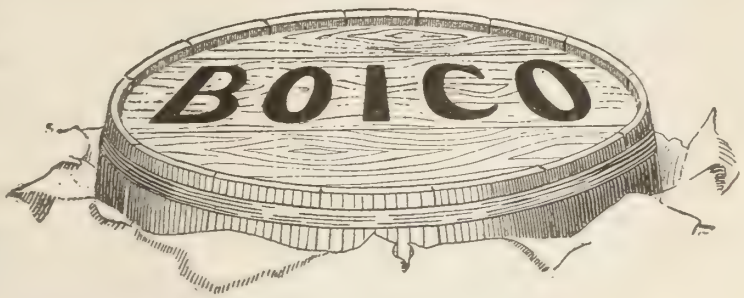
The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.** BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.



Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Sole agents for Canada for "The A-C Pressure System of Oil Burning"

Shell-Bar Boico Supply, Limited 376 Dufferin Street Toronto

Sales Agents: Mill Supply Department, Beveridge Paper Co., Ltd, Montreal; Adolphe Huot Reg'd., Quebec Adam Davis, Cobalt, Ont.

Not Just

"A Thermometer"--

But TAG Thermometers made especially to register temperature conditions in the Power Plant.

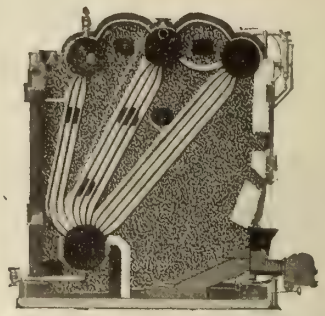
An incorrect reading is dangerous; it invariably means waste or spoilage of one kind or another.

It's not necessary to go into intricate details of manufacture here; we have a Bulletin, PP-405, that tells all about TAG Thermometers for your particular business.

They meet your requirements perfectly and are covered by an iron-clad guarantee. Not just "guaranteed," but an actual guarantee that comes with each thermometer insuring its accuracy.

Bulletin PP-405 Sent on Request

C. J. TAGLIABUE MFG. CO.
TEMPERATURE ENGINEERS
18-88 Thirty-Third St Brooklyn, N.Y.



Plastic Fire Brick in modern high stoker-fired furnace, including side and front walls, door arches, bridge wall and baffles

Seamless One-Piece Boiler Furnace Linings

Betson's Plastic Fire Brick is not a brick nor a cement, but a plastic compound of fire clays of highest refractory properties. It is properly proportioned to eliminate expansion and contraction and is used to build completely, one-piece furnace linings and to replace laid up fire brick, tile or moulded-brick linings.

BETSON'S REG. U.S. PAT. OFF. TRADE MARK PLASTIC FIRE BRICK

is not high in price, it is high in efficiency. It is economical because it out-wears other linings and is so easy to install.

This plastic material is simply pounded into place with a mallet and smoothed with a trowel. No special forms, tools or training are required to execute a first-rate job.

With it tight, permanent baffles of proper size, shape and angle to form tapering passes, can be made for any type boiler, in your own boiler room, without disturbing your boiler setting.

Betson's is the pioneer and only Plastic Fire Brick. Backed by over 20 years' satisfactory service. Write for informing pamphlet.

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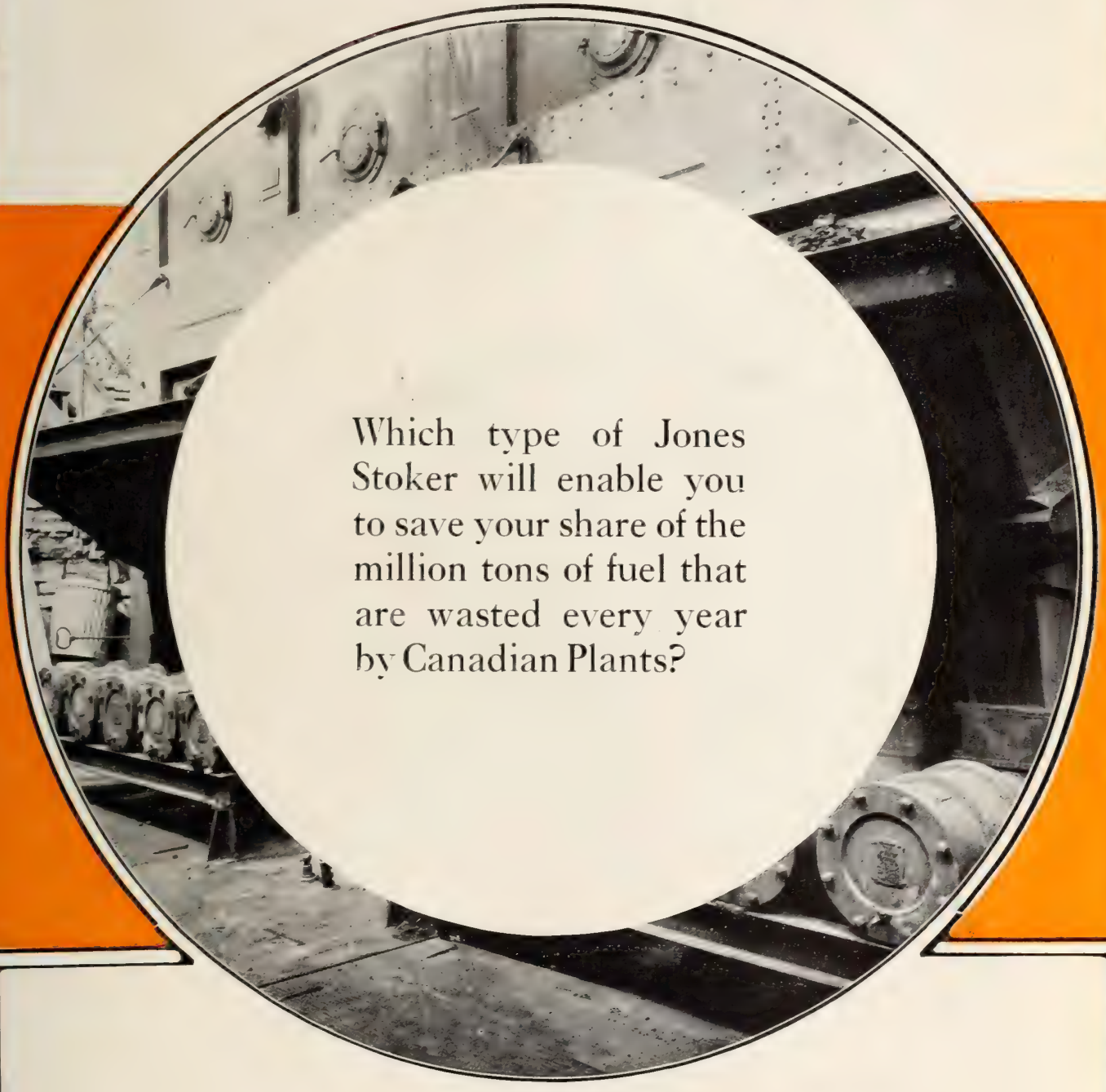

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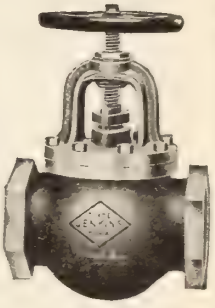

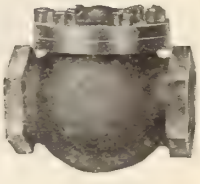

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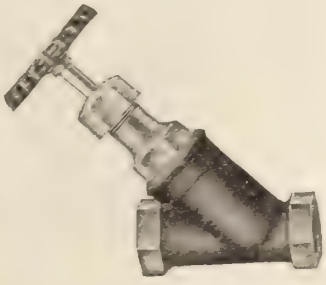

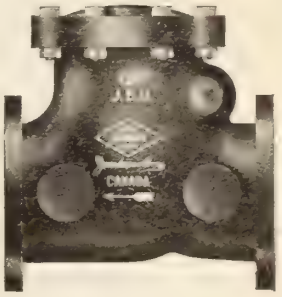

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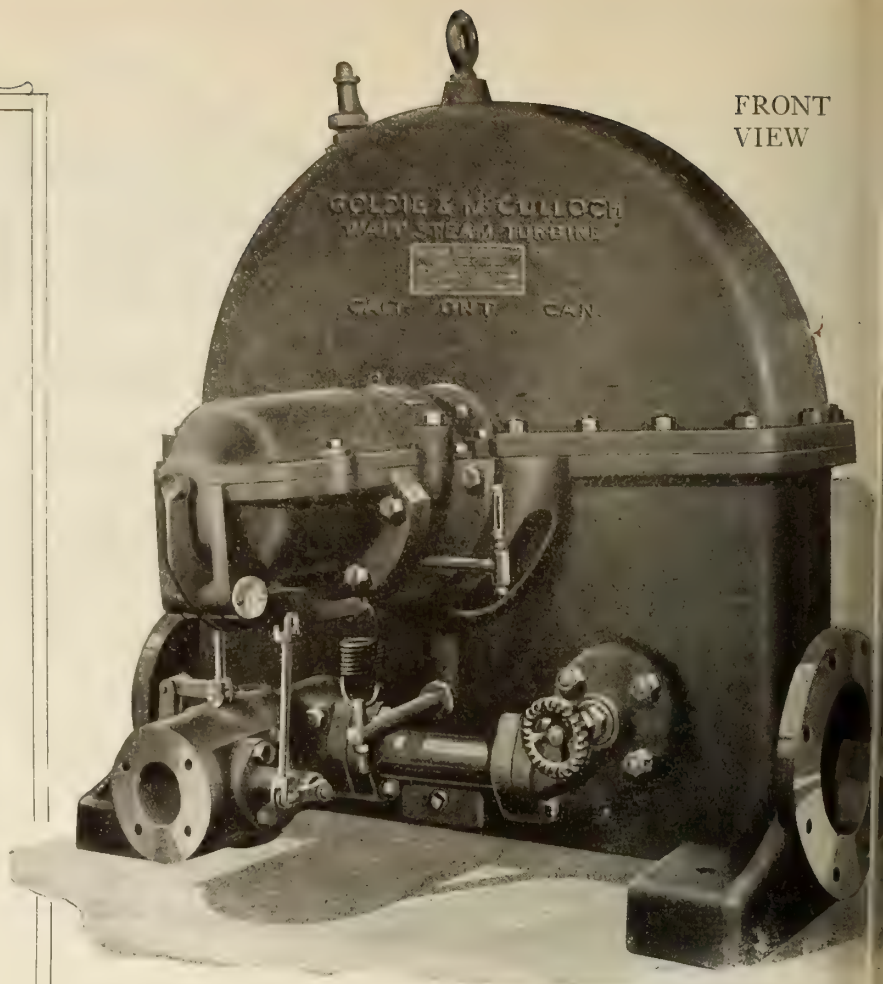

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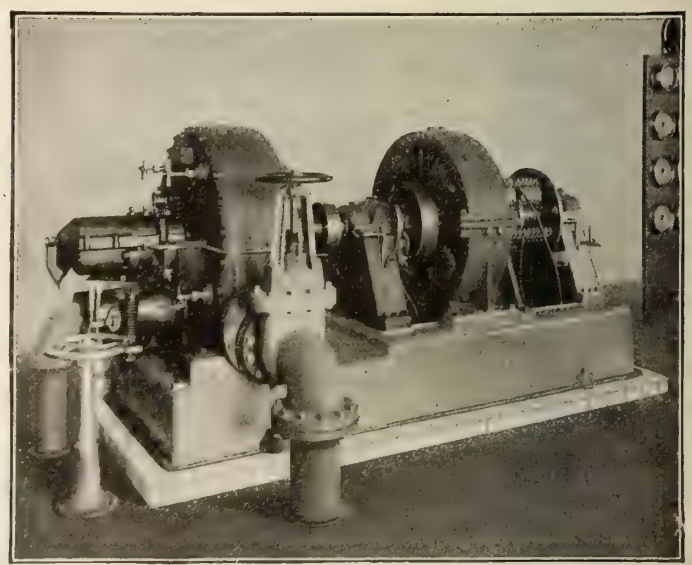

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Experiments on a Conveyor-Feed Type Stoker

As a Result of Two Years' Experimental Work, a Stoker Which Will Burn Eastern Bituminous Coal Successfully Has Been Obtained—The Author Describes Them in a Paper Before the A.S.M.E.

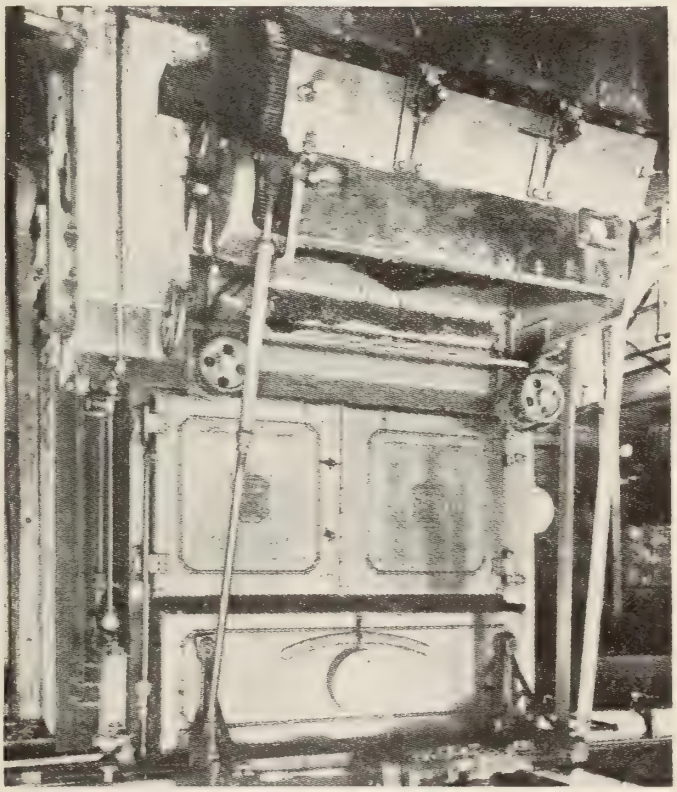
By LLOYD R. STOWE

FOR the past two years the Laclede-Christy Clay Products Company has been experimenting on a new forced-draft stoker for use with the various kinds of fuel found in this country. The boiler house of this company's Christy plant at 4600 South Kingshighway, St Louis, has been and still is being used for experimental, testing and development work. Fig. 1 shows the test boiler and stoker.

The burning of coal has always been a decidedly popular subject with engineers and naturally these two years of intensive experimentation have developed information that will be of interest to the members of this society. The stoker used employs the conveyor method of feeding, i.e., it uses progressively moving chain-grate conveying elements to feed the coal through the furnace and to discharge the refuse to the ashpit.

At the outset it is necessary that we realize the full import of the term "conveyor-feed." The conveyor-feed principle makes possible the use of grates that continually move onward in one direction. The fuel bed being supported on these moving grates is positively conveyed from the stoker hopper where fresh coal is introduced, to the discharge end where the refuse is rejected to the ashpit.

The feature of the conveyor-feed that commends its use is its handling of the fuel bed in a positive, definite fashion. By striking off the fuel evenly under a feed gate and then literally carrying it on through the furnace and over the point of ash discharge, this mechanism prevents in a large measure the evils of less positive feeding devices, namely, specifically uneven fires, balled-up spots, and immovable clinker formations. These advantages of conveyor-feeding are very attractive to the stoker designer, and as a result of this and of the fact that the underfeeds have quite thoroughly demonstrated the great advantages of mechanical draft, many builders are now experimenting on and developing various forms of forced-draft conveyor-feed stokers. In fact, work in this direction characterizes the efforts of the stoker industry at the present time, and the following particulars regarding the experimental work of the Laclede-Christy Company and the results it has attained should therefore prove of timely interest.



THE TEST BOILER AND STOKER.

It is well known that there have been many failures in attempting to burn eastern coal on chain grates. In fact, some have gone so far as to maintain that the undisturbed fuel bed of the conveyor-feed is so poorly adapted to eastern coal that it is useless to proceed further along these lines. Others have, in all sincerity, advised manufacturers to stay with the western coals, where the conveyor-feed rightfully belongs.

Now, one of the characteristics of the conveyor-feed, it will be observed, is that the fuel bed is undisturbed during the so-called coking period, or, more properly speaking, the period of destructive distillation. It is largely because of this feature that the author has elected particularly to relate what has been learned about eastern coals with conveyor-feed—coals high in heat value and low in ash and including those termed semi-bituminous and caking. And it may be as well to state at this point what may be considered as the conclusion of this paper: Namely, that the results of these experiments undertaken indicate that conveyor feeding can be used successfully with eastern bituminous fuels.

For many years it has been quite clearly established that nearly every re-

quirement of a successful stoker is lacking when burning caking fuels on chain grates with natural draft. The coal cakes almost immediately upon entering the furnace, high rates of burning cannot be secured, the combustible content of the ash is high, the admission of the air is not properly graduated to the requirements of the various stages of combustion, and maintenance of links is excessive. This is indeed a complete indictment, and with the sole exception that the automatic features are always in evidence, it may be said that the performance of chain grates on eastern bituminous coals violates every requirement of a successful stoker.

It is well known that the caking property of eastern coal is the most serious obstacle in the way of the successful use of this fuel on chain grates. In endeavoring to burn Pocahontas and similar coals it is observed that tarry oils flow through the fuel bed as a result of the application of heat at moderate temperatures. It is further observed that the coal under the arch is caked or coalesced by these tarry oils, and forms a sticky blanket that prevents the entrance of air through the coal and hence checks combustion and heat generation under the arch.

In attempting to remedy this situation the most natural thing to do is to employ mechanical means to break up the caked fuel bed, which is the course almost invariably taken by the inventor. In fact, the idea is prevalent that "A mechanical agitation of the fuel bed, for the purpose of breaking up the coke, is necessary or advisable when burning eastern coals." So many statements have appeared similar to the one just quoted that mechanical engineers have come to accept it as a basic fact. The results obtained at the experimental plant, however, have disproved this contention and in doing so have made possible the application of conveyor feeding to the burning of eastern coals.

Causes of Coke Formation in Stoker Practice and Its Prevention

All bituminous coals have a small resinous content that flows when heat is applied. In certain coals this resinous material has decided adhesive or binding properties and hence agglomerates the coal particles into a primary mass when it flows under the application of heat. This mass is the starting point of coke formation and out of it true coke may be formed by further actions that take place in the fuel bed. It must be noted here that while all bituminous coals have this resinous content its adhesive or binding property is lacking in the western, or free-burning coals.

It appears that the higher the oxygen content of the coal, the less pronounced will be the primary caking tendency. Analyses on a moisture-and-ash-free basis show that eastern coals contain less than half as much oxygen as do western coals of non-caking characteristics. Furthermore it is well known that eastern coking coals lose their caking properties by weathering, and it has been determined that weathering causes coal to absorb oxygen and to increase in weight by the weight of oxygen absorbed.

The absorption of oxygen can be accelerated and be made to take place in the boiler furnace by producing very high coal temperatures and accompanying these with a plentiful supply of air. In other words, this feature of weathering can be artificially carried on in an exceedingly short time. The oxygen absorbed apparently destroys the adhesive qualities of the resinous material referred to above and hence the primary mass from which the coke structure is later formed is not produced.

Again, when heat is applied to any bituminous coal, a chemical rearrangement or breaking down of certain of the compounds in the coal takes place. This action produces the greater part of what is termed "volatile matter," the remainder coming from the resinous content. The initial product of this chemical rearrangement is no doubt further decomposed into a fixed gas and a tarry residue. This tarry residue has not in itself the properties of a very strong binder, but it does build up and materially strengthen any primary coke structure that may already be present by leaving a film of carbon behind when the final breaking down into this carbon and fixed gas has taken place.

The foregoing theory accounts for the non-caking performance of eastern coals in the experimental work referred to in the present paper, and in its essentials seems to be the theory most commonly accepted by coal and coke analysts.

In the experiments with the new stoker the ignition temperatures are extremely high and at these temperatures considerable amounts of air are forced through the fuel bed, thus providing for the absorption of sufficient oxygen in a short time to destroy the initial caking tendency. Moreover, it is reasonable to suppose that these unusually high temperatures at the same time cause a quite different procedure during destructive distillation than that which obtains with lower temperatures. That is, these extremely high and unusual temperatures completely decompose both the resinous excretion and the remaining or major part of the volatile-forming matter before the former can set up an appreciable primary structure, and before the carbon of the latter can have time to impregnate any slight primary structure that may have formed.

The absence of coke formation changes completely the character of the fire under the arch and has almost as marked an influence on the last half of the fire because since coke is not formed in the distillation zone the cemented coke lumps cannot be present in the final stages of combustion. The individual pieces of coal retain their identity exactly the same as when Illinois coal is used, with the result that the fuel bed has the soft, incandescent and fluffy appearance which every chain-grate fireman realizes means economy and high rates of burning. The absence of coke formation in the final stages of combustion will be mentioned again.

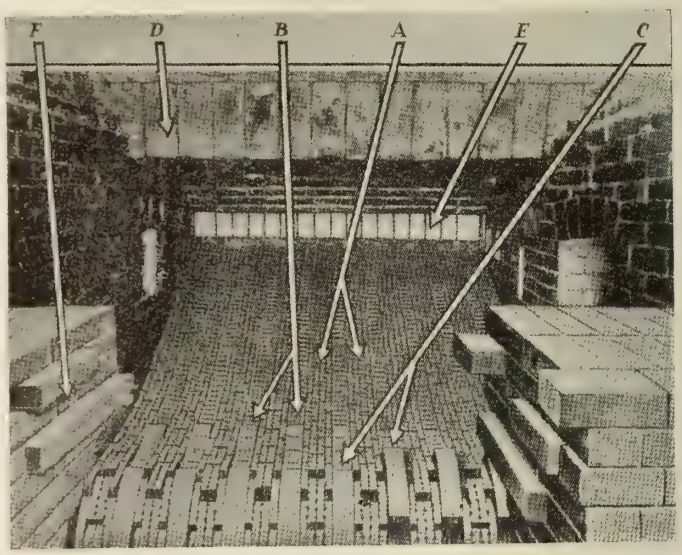


FIG. 2—VIEW OF THE GRATE SURFACE AND FURNACE TESTED.

The New Stoker

A description of the final apparatus decided on is advisable at this point for the purpose of showing how the high initial temperatures are obtained. Fig. 2 is a view of the grate surface, its general incline being 20 deg. The arrows indicated by A point to narrow chain grate or conveying elements, about 4 in. wide and placed on 7-in. centres. In the intervening 3-in. spaces are placed stationary tuyeres indicated by arrows at B. At the lower end of the grate surface the tuyeres B terminate in short pivoted bars C which are made automatically to rise above, then drop below, the surface of the conveyor chains. This action takes place slowly. D is a feed gate, adjustable to give various thicknesses of fire exactly as on a chain grate. Partly overhanging the vibrating bars C is the bridge wall E, shown cut away in the centre. An ignition arch

is shown at F. This latter provision conforms to chain-grate practice except that with the greater incline of the grate the arch is farther away from the fire. Fig. 3 shows a cross-sectioned side elevation of the stoker and boiler.

Close study of chain-grate practice has revealed much in the art of building up high ignition temperatures. A great expanse of bridge wall extending from a point horizontal with the arch to or nearly to the fuel bed is known to be of utmost value in directing heat on to the incoming fuel. This is the surface indicated by A in Fig. 3. The steep incline of the stoker in question permits this dimension A to be greatly extended over that possible with the ordinary chain grate. Moreover, it exposes the fuel bed more directly to the intense heat reflected from the bridge wall and the flame in front of it.

The form of arch was also taken from chain-grate practice and its design and placement has, of course, contributed its part toward the building up of the high fuel-bed and ignition temperatures that play so important a part in preventing the caking and ultimate coking of the fuel.

As to the admission of a generous supply of air (the second requirement for coke prevention), the greatest percentage of the total air supply is supplied under moderate pressure through that part of the fuel bed under the arch. This air supply, coupled with the very high fuel-bed temperatures obtaining, quite effectively destroys any inherent caking tendency of the fuels thus far tested, and made it possible to burn eastern coal with a considerable degree of satisfaction.

In view of the troubles known to exist with eastern fuels when using a stoker that conveys the fuel undisturbed into the furnace, the author deems it advisable to give a further description of the stoker in question in the light of what is required today in the economical burning of coal for the generation of steam, touching particularly on those features that have been conspicuously faulty in chain grates. The following outline presents the entire situation at a glance, and later in the paper each of the items therein is briefly touched upon.

It is of interest to note that the difficulties with chain grates on eastern coal have been violations of the essential requirements of the modern stoker, so it is not surprising that the opinion prevails that success cannot be obtained with eastern coals using the conveyor-feed.

An adequate treatment of the first-mentioned stoker requirement in the foregoing outline would entail a discussion of what takes place in the fuel bed and would involve a consideration of the various types and feeds of stokers, but as such a discussion is outside the purpose of this paper this requirement will be discussed only as to the essentials upon which everyone will readily agree.

Present-Day Requirements of an Automatic Stoker Compared With the Performance of Chain-grate and Conveyor-Feed Stokers, Each Using Eastern Coals.

	Requirements of the Present-Day Stoker.	Results Obtained with Eastern Coals. With Chain Grates	Results Obtained with Eastern Coals. With Conveyor-Feed Stoker Described
1	It should completely burn all combustible that arises from the grate, and perform this task under the great handicap of using no more air than is required	Thin fires spotted with upstanding coke result in excess air and low CO_2 due to the fact that the air supply is not graduated down to a minimum at the rear of the stoker and to influence attending the coking of the fuel bed	Graduation of air supply and thickening of fire near point of ash discharge and the prevention of coke assure a consistent 10 to 12 per cent. CO_2 content with positive assurance of an intimate mixture of air with combustible gas.
2	It should bring about low combustible in the ash.	Combustible in the ash from 30 to 50 per cent.	Combustible in the ash from 16 to 24 per cent.
3	It should burn coal at high rates of burning — not only to obtain high capacities but to widen the range of economical rates of burning as well, in order that great flexibility may be assured.	Rates of burning from 25 to 35 lb. of coal per sq. ft. of grate surface per hour.	Rates of burning up to 60 lb. of coal per sq. ft. of grate surface per hour.
4	It should be as nearly wholly automatic in operation as possible.	Successful in the matter of automatic operation.	Successful in the matter of automatic operation.
5	It should not entail unreasonable expense in the upkeep of the grate surface or of the furnace brickwork.	No unusual maintenance cost for furnace brickwork, but a very high one for grate links.	Use of mechanical draft imposes a more severe condition for furnace brickwork, requiring a higher grade of refractories, but maintenance of ironwork is not excessive — in fact, may be considered quite satisfactory.

Air Distribution

Rather exhaustive surveys of the gas composition in various parts of the furnace were made frequently during the development work. These surveys showed that the zone of destructive distillation yields far greater quantities of combustible particles than does that well-spent portion of the fuel bed near the bridge wall. It follows, then, that air distribution must be regulated to supply large quantities of air to the coal during the early stages of combustion and limited quantities as the fuel nears the place of ash discharge.

It will be generally admitted that in order to burn completely all the fuel with a minimum of air it is of prime importance to provide each particle of combustible with its own quota of oxygen-giving air just as it rises from the fuel bed. The tuyere construction is well suited to such a requirement and lends itself admirably to these experiments. The tuyeres are cast in interchangeable sections containing varying percentages of air openings. This feature permits any desired gradation in air spaces to be made, between the two extremes noted in the tabulation below.

It is important at this point to recognize that the wind-box pressure is uniform under the entire grate. This provides high draft intensity and high air jet velocity for all parts of the fuel bed.

Low Combustible in the Refuse

The reduction of the combustible in the refuse to a satisfactory figure was brought about by taking advantage of the four following factors that have a vital influence on the character of the refuse: (1) Strong ignition; (2) A free-burning fuel bed; (3) Thickened fuel bed near the discharge end of the stoker; (4) High draft intensity through the nearly spent fuel.

The strong ignition temperatures have been referred to previously. On the conveyor-feed type of stoker, the coal burns from the top downward during the early stages, and from the bottom upward during the remainder of its travel. The higher the ignition temperatures, the quicker this reversal is established. An early burning from the bottom upward is recognized even in chain-grate practice, as being most effective in bringing about low combustible content of the refuse.

In a caked fuel bed of eastern coal, the air breaks through only at the fissures or cracks. Naturally the burning starts only at these fissures, and as it continues, holes are formed in the fuel bed. As the holes increase in size, the rate of burning decreases, due not only to the cooling ef-

Table 1—Air-space Distribution Adopted for Conveyor-feed Stoker.

Air space in each element at feeding end		Air space in each element at discharge end	
Conveying elements	8 per cent.	Conveying elements	8 per cent.
Tuyere elements	22 per cent.	Tuyere elements	2 per cent.
8 per cent of 60 per cent.	= 4.8 per cent.	8 per cent of 60 per cent.	= 4.8 per cent.
22 per cent. of 40 per cent.	= 8.8 per cent.	2 per cent. of 40 per cent.	= 0.8 per cent.
Total air space	=13.6 per cent.	Total air space	= 5.6 per cent.

Conveyor elements, about 60 per cent. of total grate surface.
Tuyere elements, about 40 per cent. of total grate surface.

fect of large columns of cold air but also to the lessening intensity of draft occasioned by the increase in the effective air openings. This action results in a fuel bed characterized, in the final stages, by isolated lumps of coke surrounded by patches of bare grate. To prevent exceedingly low CO_2 the operator must run these bare patches out of the furnace and consequently dump the intervening or accompanying coke lumps into the ashpit.

With coking prevented and with each individual particle of coal preserving its identity, the air filters upward evenly throughout every part of the fuel bed. Freed from localized burning the fire now appears soft, intense and highly luminous.

The thickened fuel bed near the discharge end is brought about by the retarding mechanism described. (See Fig. 2.) When elevated the short pivoted bars C raise the nearly spent fuel above the chains, thus holding it back, and when depressed permit the conveyor elements to carry the ash out of the furnace. The relative duration of these two influences can be controlled by the operator and the fuel bed near the discharge end of the furnace can be held back and thickened to any desired depth.

The high draft intensity in connection with this thicker fuel bed has already been mentioned under the paragraph on air supply. Full wind-box pressure at this part of the grate forces high velocity air jets into the thickened bed and hence is particularly advantageous in burning out the remaining particles of combustible.

High Rates of Burning

From the foregoing references to mechanical draft it is quite apparent that high rates of burning are attainable with this new type of stoker. The replacement of the typical plastic fuel bed with the free-burning, intensely active bed obtained with the new equipment, materially assists in securing higher rates of coal consumption. High CO_2 results quite naturally from (a) the proper air distribution described; (b) the thicker fuel bed particularly at the discharge end; (c) the higher fuel bed temperatures that cause increased chemical activity; and (d) the impinging jet action on the fuel particles produced by small air spaces and forced draft.

FIG. 4 DETAILS OF THE CONVEYING ELEMENTS MARKED "A" IN FIG. 2.

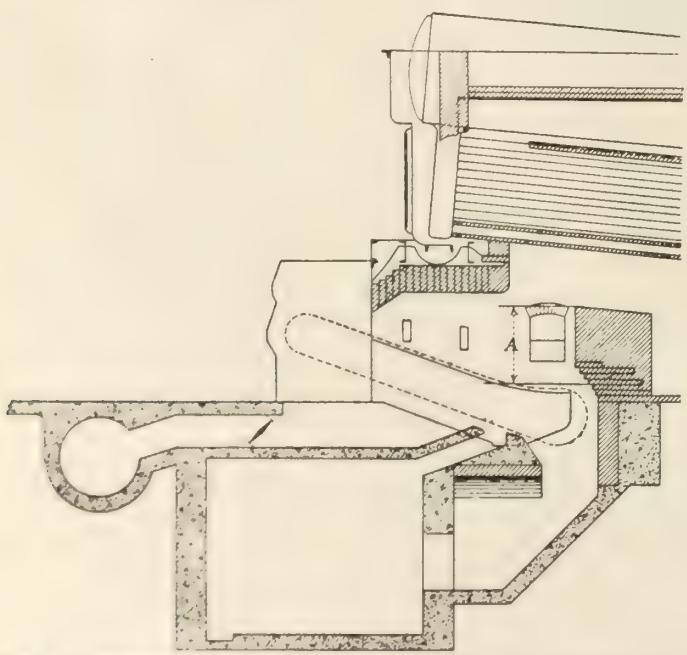


FIG. 5 SECTIONAL ELEVATION OF BOILER AND STOKER.
[illegible] heating surface and stoker 40 sq. ft., ratio 62½ to 1.)

Automatic Operation

In the matter of automatic operation it is only necessary to recall the basic principle of the conveyor-feed stoker — a positive feed fuel coal hopper to ashpit. The only action that interferes with this automatic and continuous performance and requires more than a minimum of attention from the operator is the formation of clinker on the side walls. This clinker accumulation is no more serious than with chain grates but experiments are under way to still further minimize the evil.

Eastern coals require less side-wall slicing than do those from the Middle West, probably because of the lower ash content with its higher fusing point. Also such coals have higher heat value and hence greater firing stability than Illinois coals. Because of these two advantages, the firemen of the experimental plant prefer eastern coals to those from the Central West when burned on the new stoker.

Low Maintenance

The thin uneven fuel bed at the discharge end of a chain grate combined with the low ash of eastern coals exposes the grates to the heat of the furnace. Moreover, with caking coals and chain grates, the procedure of partially closing the damper to raise the CO_2 content of the gases is too often resorted to, and such a practice invariably results in over-heated grate links.

The stoker herein described, by employing a deeper fuel bed and a thick layer of refuse near the bridge wall, effectively protects the grate from the heat of the furnace. In addition, full advantage has been taken of the cooling action of the incoming air. The small air spaces and the employment of mechanical draft produce high air velocities and this makes for cool links. An excellent idea of the very different character of the new link for eastern

coal and forced draft is obtained from Fig. 4.

High rates of burning and high furnace temperatures of course subject the furnace brickwork to very severe service. However, the wind-box pressures are low (less than 2-in. water column) and this, combined with the large number of uniformly distributed miniature air openings, causes the impinging flame or blow pipe action to disappear quite near the surface of the fuel bed, thus minimizing to some degree the brickwork deterioration.

The problem of more severe furnace conditions has thus far been met by employing refractories of a higher grade. The side walls and bridge wall have been made with standard 9-in. shapes and the writer is advised that the higher refractoriness of the brick used is in part due to its higher percentage of alumina and its low content of fluxes. Regarding the ignition arch, both the process and the mixture are new in stoker work. The material is highly refractory and porous and its performance under the harder usage bids fair to rival the ordinary arch maintenance in chain grates.

The essential points of this paper have been sufficiently marked to require no summary, but it may be said in closing that those connected with the experimental plant have derived considerable satisfaction in attaining the degree of success noted through the employment of such simple means.

COLOR SCHEMES FOR PLANT PIPING

By H. L. Wilkinson

The importance of some definite and unmistakable means of readily distinguishing between the various pipe and conduit lines and systems in the power plant has long been recognized by both designing and operating engineers. Particularly in large power plants is this question of vital importance, and it should be stated that in some of the well-ordered large power plants reasonably satisfactory systems have been installed. Also there has been some effort made to standardize this practice, a committee appointed by the American Society of Mechanical Engineers to investigate the question having reported upon the preferable distinguishing colours for the various divisions of piping systems in the usual power plant, so states the author at a recent meeting of the American Society of Heating and Ventilating Engineers.

While the importance of standardization in this detail of our power plants has been recognized, too little attention has been given to the matter of late, and the writer believes that its importance should not be overlooked. It is, therefore, suggested that the members of this society consider the following plan which is designed to apply to all piping systems.

It will be noted that the recommendation involves, in addition to piping lines, colour schemes for machinery, motors, hand-rails, dadoes, waste pails, elevator cages, etc., thus extending the usefulness of this distinguishing system to all parts of the industrial plant. It has been a revelation to the writer to find the cordial reception which this proposed colour scheme has received in many industries and concerns of national prominence, and the result is that new industries and concerns are taking it up continually. The application of this standardization might well be extended to the designating by distinguishing colours the tools used in various departments of a plant. This would bring about several benefits. In the first place, it would enable managers to hold each department of a plant responsible for its own tools. Then, because of the improved appearance of the tools, it would create more interest in their care on the part of mechanics. Last, but not least, it would surely be an insurance against tools being carried out of factories.

While the scheme designates definite colours for certain pipes, it is, of course, unnecessary to apply any one particular colour on any one pipe, the arrangement being flexible, so that an engineer may determine for himself his own design. In some cases, where there are as many as fifteen to twenty-five various pipe lines, it is necessary to use combination colours on some pipes, painting the straight pipe one colour and the joints, valves, elbows, etc., the alternating colour. Of course, some exceptions to personal selection will be found where an established custom has been in effect for some time, as in the case of sprinkler-pipes and all fire lines, where vermilion is the logical colour.

The advantage of this standardization will become readily apparent from the case of a certain plant where there was a stoppage or break in one of the pipe lines. The workmen carefully followed the line to the side wall where the trouble apparently existed, and opened up the wall for a considerable area, only to be confronted with everything but the line they sought. Of course the expense of ripping out the wall was nothing compared to the inconvenience and loss sustained, due to the suspension of operation until this repair was made. If this pipe line had been printed with a distinguishing colour and a small arrow placed on the wall where the pipe entered, indicating the direction the pipe took after enering the wall, all this difficulty would have been obviated.

NON-DESTRUCTIVE METHOD OF BELT JOINING

An unusual problem in the handling of hot cement clinkers with a temperature of 200° and over, was recently solved at the plant of the Standard Portland Cement Company, Leeds, Ala., in an interesting and cost-reducing manner. The method decided upon for moving the clinker was a rubber conveyor belt, but the clinker could not be cooled sufficiently in the process previous to conveying, to prevent scorching of the belt and its rapid destruction. The answer to this problem was found by running the belt at an incline of 12 degrees, so that the lower pulley dipped into a trough of water, thus carrying a film of cold water upon the belt, on to which the hot clinker from the loading hopper was deposited.

At this point a new problem was encountered; namely, how to join the belt so that the belt's full strength would be retained, and in a way which would withstand the extremes of temperature, the wear on the pulleys and the abrasion of the clinker. For this purpose Crescent belt fasteners were adopted, because they brought the belt ends tightly together in a snug joint, which made the belt practically endless on the pulley side, so there was no opportunity for clinker ash to get into the joint and abrade the belt ends, and also because in this method of joining, no metal came in contact with the pulleys to cause wear, and a permanent joint was thus assured. Moreover, the exceptional strength of the heads of the rivets and the formation plates prevented destruction of belt joint through abrasion by the clinker.

In six months of operation, this conveyor has carried 61,000 tons of clinker, and the Standard Portland Cement Company credits the saving of $300.00 in belt cost alone to this conveyor. The belt used was Goodyear Hy-temp, which is made particularly to withstand temperatures up to 200°, and is adapted for work on conveying jobs in mines, coking plants and cement factories where heat resistance and ability to withstand hard wear are prime requisites.

One of the most conspicuous forms of British engineering activity since the war lies in the growth of locomotive production. Every country in the world wants locomotives, and the extension of many locomotive shops in both England and Scotland, is designed to ensure that the demand will, as in the past, be met.

It is so far to the good that most of these shops were retained on locomotive work during the war. One firm alone supplied 152 locomotives to British railways, 380 to the French railways, and 300 for other overseas countries during the war. This was in addition to producing many narrow gauge locomotives, hundreds of "Tanks" and hundreds of thousands of shells, numerous aeroplanes, torpedo-tubes, gun carriages, and other "munitions." The total value of the company's output during the war was sixteen million pounds.

The Kelly Foundry and Machine Co., of Goshen, Indiana, have issued their catalogue G dealing with rocking, dumping, and stationary grates. The catalogue is well illustrated, and shows, besides the various types of movable grates, some portable kiln grates, stationary fire bars, and boiler front castings.

Common Sense in Engineering

A Lecture Delivered During the J. E. Aldred Lectures on Engineering Practice at John Hopkins University.

By WALTER M. McFARLAND

(Continued from last issue)

A very important feature in your engineering education and experience is to discover in any specific case the general principle which is involved and which may often be utilized to advantage elsewhere with considerable differences of detail from the original case. A circumstance of this kind came under my observation which illustrates the point quite well.

It was customary in the engines of the Navy up to about the beginning of t so-called "new navy" to make the eccentric straps of brass. Somewhat earlier than this, when steel castings had become available, designers for engines of the merchant service had made eccentric straps of steel castings lined with white metal, the idea being, of course, that the white metal furnished the suitable bearing surface, while the steel casting gave adequate strength. The steam launch on one of our vessels had the eccentric straps made of brass, as usual, half an inch square in cross section, and one of them broke. It was the lower half, which was a half circle with lugs to bolt to the other part. The young engineer who was charged with the repairs did not know of this practice in the merchant service, and having always seen eccentric straps made of brass, tried to make a temporary repair by taking a couple of sheets of one-quarter inch sheet brass, bending them to shape, riveting them together with a few copper rivets and bending over the ends to make lugs for attachment to the other part of the strap. Unfortunately, sheet brass is rather brittle, and, as might have been expected, this temporary strap broke off where the lug had been bent. After trying this a couple of times he was about to give up the attempt at repair and have a new strap made at a shop on shore. Another young engineer on board knew of the practice in the merchant service. It was out of question, of course, to get a steel casting, and it would have been difficult to arange for using white metal, but he remembered the principle of a proper bearing metal to go against the eccentric, backed up by a stronger one to stand the stress. Accordingly he took a piece of half-inch square bar iron, had it bent to shape and faced it with one of the strips of one-quarter-inch sheet brass, securing it to the wrought-iron backing with the copper rivets. This was properly fitted to secure a good bearing, and, of course, worked with entire satisfaction. Later on a new brass strap was secured for use, if necessary, but the repair was so satisfactory that the new strap was never used.

From the circumstances existing in educational establishments it is practically a mater of necessity that in solving problems the data should be furnished you and your work should be chiefly the handling of these data. When you get out into actual practice an exceedingly important part of your work will be the securing of these data accurately, which means that the observations must be made with care and with the aim to be thoroughly correct and reliable. It is not always possible to devise simple checks on the observations which will tell at once whether the records are reasonably accurate, but there are many cases where such checks do exist, and you should endeavor, if possible, to ascertain what such checks are. Some will come from previous observations and experience, some from study, but a great many will be a matter of common sense. A striking case which came under my observation and where common sense was the check is worth telling.

Most of the Mediterranean ports are protected by breakwaters so that the water inside is smooth, and as a result when coal is brought off to vessels it is in rectangular piles on flat scows. Unfortunately, coal dealers in the Mediterranean have a rather bad reputation for trickery. Consequently, in naval vessels when coal is taken on board great care is used in measuring the coal piles so as to be sure of the amount received. I was attached to a vessel which called in the harbor of Algiers. A couple of our midshipmen were detailer to measure the coal piles which were, roughly, 40 feet long, 20 feet wide, and between 5 and 6 feet high. At the end of the first day they handed in figures to show the amount received, which came to 375 tons. The executive oicer of the vessel had been attached to her for some two years, and so was familiar with the rate at which coal could be taken in. He said at once that some serious mistake had been made for the reason that never before had more than 300 tons been received in one day, even when the conditions were better for rapidity than existed at Algiers.

The midshipmen were told to go over their work again to see if there was any mistake, and they examined their computations but could find no error. I was the possessor of a slide rule, and was, therefore, supposed to be something of a expert on figures, and was called in to see if I could find what was wrong. I had had nothing to do with the coaling, but was on board during the day, and happened on several occasions to notice the young men while they were making their measurements. I checked up some of their arithmetical work and found it was correct, so it seemed that the trouble must be in the measurements themselves. I remembered that when I saw them making the measurements the particular piles on which they were working did not come above their heads, while I noticed a great many heights recorded as being over six feet. The solution of the difficulty then occurred to me at once. They had used one of the tape measures from the engine room. If you do not know it now you will learn by experience that the ordinary linen tape measures are fitted with a brass ring in the end for convenience and to prevent the tape from slipping into the case. These rings are invariably torn off after a relatively short service, and the common practice is then to tie a knot in the end of the tape and to make all measurements from the 1 foot mark. I asked the midshipmen if they had used the linen tape, and found they had. It appeared on further investigation that the man who held the knot recorded the figures, which were caled off by the man at the other end. The recorder assumed that the other man had deducted one foot before calling off the measurement, while the man at the other end called off what he saw, assuming that the recorder would deduct one foot. There would have been no easy way to check this on the measurements of 20 feet and 40 feet, but obviously it was absurd to put down heights of 6 feet 3 inches and 6 feet 6 inches when, as a matter of fact, they were looking over the piles. Remembering that when I saw them the piles were below the tops of their heads, I asked them if there were any piles which they could not look over. On reflection they said that there were none. I asked then where they got their heights of over 6 feet, and at once the error developed that every measurement they had made was one foot too great. When the correction was made the amount of coal received was only 275 tons instead of 375.

As you hear the story you may think that these young men were unusually stupid. As a matter of fact, this is not true at all, and both have since made enviable records in the navy. They simply failed to use common sense in applying the obvious check as to height when they could look over the piles of coal, which should have at once have called their attention to the carelessness with which they were making the measurements.

While speaking of this subject of checks on observations you will in time

acquire a great many of these from practice and experience, and it is well to do so as soon as possible. For example, with good average coal of, say, 14,500 B.t.u.'s pepr pound, if all the heat went into the formation of steam (that is 100 per cent. efficiency) you would have evaporation from and at 212° F. of about 15 pounds. Likewise, with good quality fuel oil of, say, 19,500 B.t.u.'s the corresponding evaporation would be about 20 pounds. These are figures easy to remember, and when you remember in addition that the best average results in good boilers are about 75 per cent. efficiency with coal and from 80 to 82 per cent. efficiency with oil, you will be in a position to discourage fairy tales about remarkable performances in the way of boiler efficiency. It is the custom now in all carefully-conducted boiler tests to tabulate what is known as a "heat balance," showing the way in which the heat in the fuel is distributed. Two elements of loss which are present in every fuel are the heat carried away in the dry chimney gases and the loss due to moisture formed by the burning of hydrogen. The sum of these two losses at moderate rates of combustion is, roughly, about 15 per cent. in the case of coal, and about 14 per cent. with oil fuel. You will see at once that if all the other losses are eliminated the possible efficiencies would be only roughly some 85 per cent. Consequently, if figures are shown you indicating an evaporation of 13 or 14 pounds of water per pound of coal, or 18 or 19 pounds of water per pound of oil, you will know at once that these results are impossible. Either there has been excessive priming of the boiler or there has been an error in the observation of the amounts of fuel and water.

Some years ago a friend of mine who is a very able engineer was discussing the matter of what is known as "surface combustion," where the gassified fuel passes through a porous earthen plate and burns on the surface. He asked if I had gone into the matter carefully, and I told him that while I had read something about it, I did not know very much. He then went on to say that it was a matter of the very greatest importance because the efficiency with this method of combustion was claimed to be five or six times as great as by any other method. I reminded him at once that this was absurd because a good average performance with oil fuel gave 80 per cent. efficiency, and five times this would have been 400 per cent., which was, of course, ridiculous. He then concluded that the ratio of five or six times referred to the efficiency of an open grate or some other similar very inefficient method of burning coal.

While as engineers we always want our work to be accurate, common sense teaches us that there is a time for everything, and there are often occasions where you want to reach a decision quickly and where approximate data will be just as useful as those which are absolutely accurate. You will find as you go along that there are a number of "thumb rules" or "round figures" which are very convenient to carry in your memory for just such occasions. For example, a square foot of sheet steel one inch thick weighs approximately forty pounds, which gives you a "round figure" easy to remember and easy to divide for sizes which you are likely to need. The error is only about 2 per cent. Again, one foot in length of a tube four inches in diameter gives one square foot of surface, and two feet long of two inches diameter, and four feet long of one inch diameter. Here the error is a little greater, being about 4 per cent.

There is another convenient figure to remember at the present time—when the question often comes up as to whether it will pay to change a coal-burning installation to one using oil. If you will take the relative thermal values of oil and coal and allow for the higher efficiency when using oil than coal, which is, roughly, about 10 per cent. of the efficiency with coal, you will find that the cost for the same thermal value of fuel may be expressed as follows:

When the price of oil in cents per gallon is half the price of coal in dollars per ton (of 2,240 pounds) the cost for the fuel only is the same. In other words, two-cent oil costs the same as $4 coal. There are economies in using oil due to a smaller boiler-room staff, the absence of ashes and other things, which must be considered, but this "thumb rule" will often enable you to say whether the step is worth considering at all. For example, if oil is selling at five cents a gallon while coal can be obtained for $5 a ton, it is perfectly evident that the difference in the cost of the fuels is so great as to make it unwise to change. If, however, oil, say, is four cents a gallon and coal $7 a ton, the difference is then so small that it is possible the other savings would justify shifting over to oil, so that it is advisable to make a detailed investigation.

From one point of view the talk that I have given you may be regarded as rather disconnected, because so many subjects have been considered, and yet the same theme runs through them all—the application of common sense in the solution of engineering problems. Perhaps the very diversity of the subjects may impress you all the more with the great importance of common sense.

My aim has been to encourage you to develop and trust your own common sense by showing how it applies everywhere and is of the greatest service. Indeed, without it great mental ability is often helpless or goes wrong. One of the most brilliant engineers whom I know, who has designed some of our most important electrical machinery, and who is an accomplished scientist, once said "nine-tenths of good engineering is common sense." And, in closing, let me say again that common sense is not a special gift and does not replace careful study, but it does mean the application to the problem at hand of your best experience and judgment without prepossession or prejudice.

COPPER-ALUMINUM-IRON BRONZE AS AN ACID-RESISTING ALLOY

By O. L. Kowalke

Copper-aluminum-iron bronze is known to possess many valuable qualities. In tensile strength it ranks with mild steel. It can be forged while hot, and also rolled into sheets; it can be machined to a nice finish, and sound castings can be made of it, free from shrinkage-holes and blowholes. These among other qualities render the alloy suitable for bearings and gear. But very little has hitherto been known concerning its acid-resisting properties. With a view to acquire knowledge in that direction, a systematic series of tests have been made at the University of Wisconsin laboratories. The results of these tests, which were made with various acids and alkalies, are set out for detailed comparison in three tables. Only two of the bronzes experimented with are reported on; they are distinguished as A and B. Their average compositions and properties were:

	Bronze A	Bronze B
Copper	87.0 %	85.6 %
Aluminium	9.8 %	10.8 %
Iron alloy	3.14 %	3.57 %
Ultimate unit stress	74,800 lb. sq in.	66,600 lb. sq. in.
Reduction in area	19.0 %	13.0 %
Elongation in 2 in.	21.0 %	11.5 %
Specific gravity	7.71 %	7.58 %

The specimens for the corrosion tests were approximately 1 in. by 0.07 in., and were finished smooth, with square edges. Most of the tests were made at room-temperatures of 72 deg. F. and 85 deg. F., but a few were made at 194 deg. F.

Bronze A was found to be resistant to several acids, particularly to sulphuric, lactic, phosphoric, tartaric, and acetic acids. Nitric acid attacked the metal readily, the concentrated acid acting violently. Hydrochloric acid and ammonia solution both attacked the metal too readily for commercial purposes. Caustic soda had but little effect. In the case of bronze B, a strikingly higher resistance to sulphuric acid is shown. Also ammonia did not corrode it so readily as bronze A. Nitric acid attacked bronze B also too readily; and hydrochloric acid attacked it more readily than bronze A. It is interesting to note that the corrosion, in 35 per cent. sulphuric acid, of a forged specimen of bronze A is only about half that of the rolled-sheet and cast forms.

The Illinois Stoker Company, of Alton, Ill., have issued a catalogue "L," describing their natural and forced draught type of mechanical stokers. These are of the chain-grate type, those for natural draught being type A, and the force draught, type G. A preface is included, showing the advantages of mechanical over hand firing, and following this is a well-illustrated section descriptive of the two types. At the back of the book is a description of the Illinois arch, and a chapter on boiler and furnace efficiency, including several diagrams.

Some Useful Information on Gauge Glasses

The Various Troubles to Which They Are Subject Are Discussed Also Means of Preventing Some of Them—The Right and Wrong Way of Fitting a Glass is Explained

By H. E. WAVERLEY

THE glass water gauge, which is such a familiar object and may be seen on almost every boiler front, may be considered a time and labor-saving device, and to a certain extent a safety appliance also. The glass gauge, like other safety appliances, must be kept clean and in good condition at all times in order to ensure reliable indications of the water level in the boiler. It is a simple device to keep in order, and not a difficult one to repair when it gets out of order. Where raw feed-water is employed, as is generally the case where boilers are not used for power purposes in non-condensing plants, the gauge glass should be kept clean by blowing out at regular intervals. The interval between cleaning-out times depends upon the quantity and the quality of the water used. Muddy water deposits a sediment, principally mud, while clear water deposits carbonate and sulphate of lime and magnesia which form scale.

When closing the valve after blowing out the column and glass, a certain quantity of water carrying deposits is retained in the column and glass, and in a few minutes these settle along the bottom of the lower column pipe and in the bottom connection leading to the glass. If the blow-off valve be now opened a very little and for about 5 seconds these accumulations may be removed before they have had an opportunity of becoming attached to the surfaces, and without renewing the entire contents of the column and glass. By a careful manipulation of the blow-off valve under the water column, and of the drip-cock under the glass, these parts may not only be cleaned of sediment but they can to a considerable extent be kept free of such troublesome accumulations. Where the feed-water is very bad and the amount of sediment is found to be large, it always pays to be very careful when blowing out the column and glass, and to remove as much of the deposits as possible, not because of the trouble that would otherwise be experienced in removing hard scale, but to ensure accurate indications of the water level at all times and upon which the safety of the plant very largely depends. The glass water gauge in many plants is relied upon almost entirely from one week's end to the other, the gauge cocks being used in emergencies only. It is nothing more or less than criminal negligence to place so much confidence in a glass water gauge unless great care is taken to ensure its proper condition at all times, and that can only be done by frequent and thorough cleaning.

In certain works on steam engines and boilers directions are given for the proper care of the water column and gauge glass. The directions are generally to the effect that the glass should be blown out from four to six times each day, and that the gauge cocks should be tried at least once every half-hour. These directions are decidedly on the safe side in one respect, and that is that a gauge-cock cannot possibly clog or become scaled over during a single half-hour, and with the worst possible feed-water and condition of boiler. On the other hand, experience with different firemen and water tenders seems to indicate that the directions if followed to the letter eventually lead to dangerous conditions.

It must be understood that there are exceptionally careful men to be found in boiler-rooms, and there are water columns fitted with exceptionally good gauge-cocks and water gauge connections. The directions referred to are all that can be desired when these exceptional conditions exist, but under ordinary conditions the very frequent use of these important devices produces needless wear and a large amount of avoidable labor and annoyance. Gauge-cocks cannot be expected to remain steam and water-tight for many weeks when used twice an hour day after day, and when they begin to leak at very short intervals and spatter mud and water over a nicely kept boiler front the temptation to plug them, or to repair them and then neglect to use them often enough to ensure safety, is indeed very great, and too often proves irresistible. The moderate use of gauge-cocks is all that is necessary to ensure safety, and it further ensures the continued use of the gauge-cocks without leakage or other inconvenience.

Gauge glasses as a general thing break oftener when frequently blown out. There is a practical limit to the frequency with which the glasses should be blown out the same as with the opening of gauge cocks, and the limit depends upon the frequency with which the boiler is cleaned, the kind of water used, and the kind of glass gauge fittings employed. With fittings having liberally proportioned openings leading to the glass, say, not less than ¼ inch in diameter, and when the boiler is cleaned every two weeks or after 135 hours' run, four times a day is often enough to blow out the glass, and three times a day is often enough for the water column. A day is assumed to be the length of time necessary to prepare for a day's run of ten hours, and to prepare the machinery for the night after shutting down.

Glasses last anywhere from two minutes to two years on power boilers, and frequently as long as three years on boilers used for low pressure heating. Probably three or four months would be a fair average for power boilers carrying pressure of 100 pound and upward. Glasses used on power boilers are generally blown out much oftener than the glasses on heating boilers, especially in non-condensing plants. The effect upon the glass of frequent blowing, and consequently of frequent heating and cooling, is similar to what is known as the fatigue of metals. After expanding and contracting rapidly a certain number of times the glass will fail. If such a glass lasts 24 hours it will generally last a month or more. When the packing, which is soft and pliable at first, becomes dried out and hard as it will in the course of a month or two, the glass is more apt to break because it is not as free to expand as it was when the packing was first put in, and this, together with the alternate heating and cooling and the gradual wearing away due to blowing out the glass, tends to greatly shorten the life of gauge glasses when used on boilers supplying high-pressure steam.

When condensed steam is fed into the boiler, or gravitates into it from the heating system, very little deposit and accumulation of scale occurs, and the water is generally clear and of course does not tend to obstruct small passages quickly, so that the gauge cocks are seldom used, and the gauge glass is blown out at rather long intervals. Glasses last much longer under the latter conditions.

The gauge cocks should be used to check the indications of the glass each time the latter is blown out. It is important to have the fittings exactly in line with each other, and to have them large enough so as not to cause the glass to bind or to be cramped in the least. When the fittings are not in line the glass is apt to be cramped either when putting it into the sockets in the fittings or when tightening the packing nuts. When tightening the nuts around a glass when in the position indicated in Fig. 1, the tendency is to straighten the glass—that is, to bring the glass into a position parallel to the socket at the end being tightened, and this tends to bend the glass, as shown in Fig. 2. It is, of course, impossible to bend the glass consequently the glass either snaps when the nut is turned or when the glass expands when it becomes heated. Failure to notice these little points is responsible in many cases for continued annoyance from breaking gauge glasses.

Sometimes it is necessary to ream out the fitting, say 1-32-in. or 1-16-in. larger so as to give the glass sufficient free-

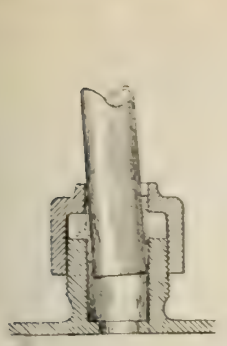


FIG. 1.

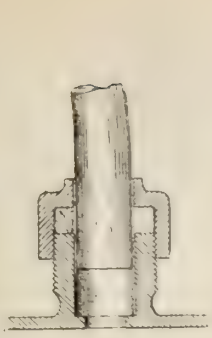


FIG. 2.

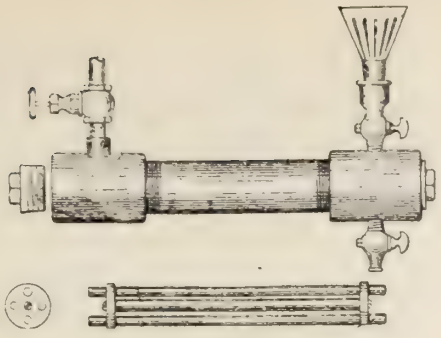


FIG. 3.

dom. Wrenches should almost never be used for tightening the packing nuts around the gauge glass. When a glass is packed with the proper kind of packing and the nuts have been screwed up just tight enough to prevent leakage when both the glass and the packing have been warmed, the glass may readily be turned around in the fittings with merely the thumb and forefinger.

After putting in a new glass turn on a very little steam, leaving the drip at the bottom of the glass open so that the steam will gradually fill the glass and escape through the drip cock. The glass is thus warmed thoroughly before the water is let into it and before it is subjected to pressure. When the glass has become thoroughly hot, open the steam valve wider, then open the water valve a like amount, and continuing to open both valves alike until fully open, then slowly close the drip at the bottom. This method not only allows the fittings to be thoroughly blown out, but enables the operator to increase the pressure on a new glass and new packing more gradually. The drip-cock should now be opened and closed suddenly. If the fittings are filled with sediment to such an extent that sudden opening and closing of the drip-cock is necessary to clear it, it is evident that the drip is not opened often enough, or that the boiler is extremely foul.

When the drip has been closed for some time the water in the glass will become comparatively cool which is due to the absence of circulation, while the upper part of the glass will become comparatively hot. As this change of temperature in the low end of the glass takes place very slowly, no trouble is experienced, but when the drip is opened suddenly and the steam is thus brought in contact with the cooler end of the glass the latter very frequently breaks, and when that is the cause of breakage the glass will nearly always fail at some point below the middle, and generally about one-third the length of the glass from the bottom.

It frequently happens that an entire package of gauge glasses will prove to be too hard and brittle, and that the entire number will break within a few minutes after putting them in. It is due to experiences of this kind that many engineers have been led to anneal all the glasses before using them. This is generally accomplished by means of a water and steam bath, the water and the glasses being heated by steam. Engineers generally rig up some apparatus with what old material they have on hand that will accomplish the purpose. A simple device that has given satisfaction for this purpose is illustrated in Fig. 3.

It consists of a short piece of 2-in. or 2½-in. pipe about 4-in. longer than the glasses. On one end is screwed a coupling with the outer end plugged, and a drip-cock screwed into the upper and lower sides. On the other end is a reducing tee, which is plugged at the outer end, and a ½-in. or ¾-in. pipe screwed into the smaller opening at the side. A valve is placed in the smaller pipe close to the tee. The vertical pipe is connected to the boiler or to one of the steam pipes. A rack made of wood is provided having suitable holes in both heads for the gauge glasses; the rack serving to keep the glasses away from the pipes.

The plug is removed, as shown, and the rack containing the glasses slipped into the pipe. The plug is then screwed in and the pipe filled with water of the same temperature as the air in the room. Both cocks being closed, the valve is opened and the condensed steam in the vertical pipe, which is practically cold, is admitted into the remaining space in the 2-in. pipe and connections. The lower drip-cock is then opened a very little thus permitting the water and condensed steam to gradually work out, which admits steam and heats the pipe and the glasses very gradually. When steam issues from the lower cock the valve is opened wide, the cock serving to keep the pipe drained. The glasses are then kept under boiler pressure, and consequently at boiler temperature for from three to four hours. At the end of that time the lower cock is closed, when the pipe at once begins to fill with hot water, the water cooling down very gradually owing to lack of circulation as the vertical pipe becomes filled. When the pipe has cooled to its original temperature the valve is closed and the two cocks opened thus draining the pipe. The plug is then removed and the glasses taken out, dried, and put away again in the box.

Glasses treated in this way have given the best of satisfaction on high-pressure boilers where the change of temperature when blowing out is very great, and where glasses are subjected to draughts of cold air, and also for portable and hoisting engine boilers, which are subjected to rather severe usage, as far as changes of temperature are concerned. Any other device which will permit the glasses to be heated very gradually and again cooled very gradually will serve the purpose fully as well as the one just described.

The bursting of gauge glasses is attended with not a little personal danger and discomfort, and it is important that all reasonable precautions against such breakage be taken by the person in charge. When a gauge glass breaks when under pressure always close the lower valve first. It is cheaper in the long run to cut glasses with a gauge-glass cutter than to attempt to cut or break them off with a broken file, or by similar means, because a slight nick in the glass at the wrong place may mean the early destruction of the glass when subjected to pressure and varying temperature.

There are other practical means for preventing the breakage of gauge glasses. Some engineers fit a thin brass or copper thimble into the upper end of the tube, as shown in Fig. 4, which prevents scale and water from coming in contact with the glass when blowing out the latter, and hence it reduces the eroded and pitted appearance commonly seen at the upper end of unprotected glasses. Tubes made of aluminum may be obtained of dealers in engineers' supplies which accomplish the same result.

These tubes and thimbles, it will be seen, protect the inner surfaces of the glass only, and as the glass is liable to be crowded to one side or the other in the packing nut as well as in the fitting itself, it is a good plan to also protect the glass on the outside. A simple means of protecting the glass on the outside is also obtained from dealers in gauge glasses.

It consists of a rubber sleeve adapted to slide over the end of the glass, as shown in Fig. 5. The glass cannot come in contact with the socket in the fitting, neither can the packing nut touch the glass when the packing is screwed up. The combination of the thimble and the latter device prevents the rapid wear of the glass at the top, and also retains the glass clear of all metallic contacts which has been found to be very desirable where glasses are subjected to high pressure and temperature and sudden changes in the latter.

When the rubber protector is employed separate packing rings are not needed, because the packing forms a part of the sleeve as shown. Annealed gauge glasses protected inside and out by this or similar means will last as long under any circumstances as it is possible to make them by any means thus far made known.

Many engineers suffer unceasing annoyance due to breaking gauge glasses because they do not pack them with the proper material. Candle wicking and asbestos wicking should be used only in case of emergency. The latter materials are too porous and require too much

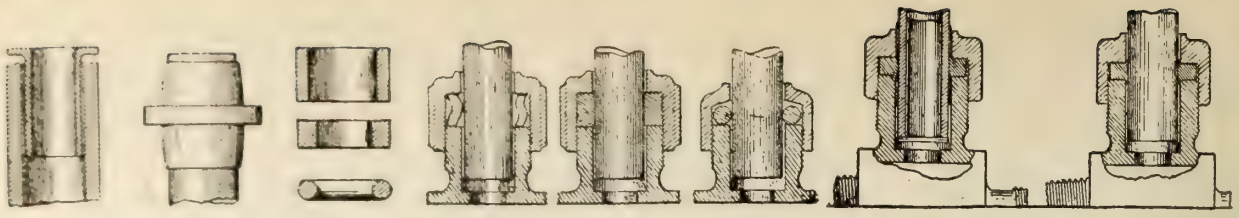


FIG. 4. FIG. 5. FIG. 6. FIG. 7. FIG. 8 FIG. 9. FIG. 10. FIG. 11.

pressure in order to make a tight joint to be suitable for packing a glass tube of any kind. The wicking soon becomes charred and hard and begins to leak, and it is evident that after it becomes hard it is useless to attempt to tighten the packing nuts. A second tightening merely serves to compress the glass so tightly as to prevent the necessary expansion, and the almost invariable result is breakage.

When a gauge glass is packed with wicking, either candle wicking or asbestos, and begins to leak at the end of, say, a month, the best thing to do is to repack the glass. Tightening the nuts on hard, dry packing, especially on an object so delicate as a gauge glass, avails nothing in the long run; but, on the other hand, it does add immensely to the number of glasses broken in a given time. Soft-rubber rings of the proper size are by far the best, and consequently these rings furnish the cheapest means of packing gauge glasses. The first cost of rubber is merely a trifle greater than that of wicking, while the life of the packing is more than doubled, and the number of glasses broken is greatly reduced.

Rubber rings are made in three forms or shapes when referring to cross-section —viz., the thimble, the square ring, and the round ring. These are shown in Fig. 6. Which of these three shapes will be found the more serviceable will depend upon how they fit the packing nut. Gauge-glass fittings are made of a variety of designs, some having a wide but shallow space to receive the packing, while others have a narrow and deep chamber between the sides of the nut and the glass. It is evident that the same form of packing cannot well be used equally well with all forms of packing nut. That is getting details down rather fine, but it is well worth considering when we remember that the durability of the glass and the safety of one's eyes depend largely upon the manner in which this work is done.

The packing ring should be of such size and shape that one ring only at each end of the glass will be required. A good job of packing gauge glasses can seldom be done when two or more rings are employed. When a rubber thimble is used on a packing nut adapted to the square ring, the result is about as shown in Fig. 7. This may be exaggerated a little, but it serves to illustrate the principle. The rubber thimble is particularly well adapted to the style of nut illustrated in Fig. 8, because the space between the nut and the glass is of the same shape, and is nearly the same size as the ring. The ring in this case is merely compressed lengthwise, and this becomes wider without any tendency to buckle or double up.

If fittings are used having a wider space for the packing, either the square or round rings give better satisfaction. The round ring is particularly well adapted to fittings having bevelled edges and nuts as shown in Fig. 9. The inclined surfaces are supposed to assist in crowding the packing against the glass, and perhaps they do, but as a general thing the bevel or angle is so slight that it is doubtful whether it is of much assistance in making a tight joint. When the edges of the fitting and nut are square, the square packing ring is best adapted, as shown in Fig. 10.

When two rings are employed the result is very apt to be similar to that shown in Fig. 7, on account of the yielding nature of the rings, and this is especially so when both rings do not fit the nut perfectly, one ring tending to crowd the other away from or against the glass, thus rendering one of the rings practically useless, and the other one less efficient. A glass packed with a protector ring, and also protected on the inside is shown in Fig. 11. It will be seen that this is an ideal arrangement when the water is muddy and the glass and water column have to be blown out frequently.

There may be found on the market at a reasonable price rubber packings adapted to every construction for gauge glass fitting regularly made; also highly annealed glasses under various trade names, and after considering the subject as thoroughly as its importance demands it will readily be seen that in order to secure a tight joint with the least possible pressure, thus avoiding any tendency to break or to cramp the glass due to the packing, it is necessary to obtain a form of packing that will fit snugly in the space in the nut.

To get the best result from gauge glasses in any service first procure a good glass, then get suitable packing and keep it in a cool, dry place so that it will not harden. See that the fittings are in line, then pack the glass and screw up the nut with the fingers only. If the glasses break frequently, try some means for protecting them inside and out, and also anneal the glasses, which may be accomplished in the manner previously explained. A little more careful attention to the seemingly insignificant detail in a steam plant will be the means of saving a great deal of needless annoyance and not a little danger of personal injury.—"Southern Engineer."

A REMARKABLE RUBBER DISCOVERY

A discovery of the highest importance has been made by a lecturer in chemistry at the Manchester (England) School of Technology. When rubber and sulphur are mixed together at a high temperature the rubber becomes hard and tough—"vulcanized" is the technical term for the change. While rubber can stand the necessary heat, other raw material with which it might be usefully mixed would be destroyed. The new invention is a cold process, in which two gases are used to produce the free sulphur required in vulcanising. When crude rubber, either in the solid or the liquid form, is treated with the two gases it becomes efficiently vulcanized, and when it is mixed with any waste material such as sawdust, leather scraps, or paper, a similar change takes place without the properties of the waste material being affected. This discovery is to be applied immediately to the manufacture of linoleum, the heavier classes of wallpaper, and artificial leather for upholstery. It is also applicable to the manufacture of one-piece boots (of rubber and leather scrap) and of felt (combining rubber and "shoddy").

ANOTHER FIRM TO BUILD DIESELS

The Worthington Pump and Machinery Corporation have issued a bulletin announcing their entry into the marine Diesel engine construction field. The bulletin reviews the marine situation and the case for the Diesel internal combustion engine, and quotes instances of actual working to demonstrate the reliability of this prime mover. The announcement of the building of a 2,400 I.H.P. six cylinder marine Diesel by the company follows. This engine was built at the company's Snow Works, Buffalo, and the cylinders are 29 inches bore by 46 inches stroke, and the crank shaft makes 120 revolutions per minute, the engine being of the 4 cycle type. The engine is built to the Worthington Company's own designs, but the leading features of successful foreign builders have been incorporated. The company have made plans to enable them to produce these engines in large numbers as the demand increases.

The Theory and Practice of Electricity

In These Articles the Theory Will be Developed Sufficiently to Enable the Practical Man to Grasp the Underlying Principles of Apparatus Under His Care, Both Direct Current and Alternating

W. F. SUTHERLAND

MAGNETISM and electricity are so intimately related that one can hardly be studied without the other. In the earlier days of electrical science this relation was not so apparent and it has only been during the past century that the true relationship has been worked out. From the study of these things indeed the whole electrical industry of to-day is largely based.

In the last lesson it was seen that the lines of magnetic force around the poles of permanent magnets could be visualized by means of iron filings. If we now take a piece of cardboard and passing a heavy wire through it cause a current to flow through the wire; by sprinkling the cardboard with iron filings we shall see the filings arrange themselves in concentric circles around the wire, much as is shown in Fig. 22.

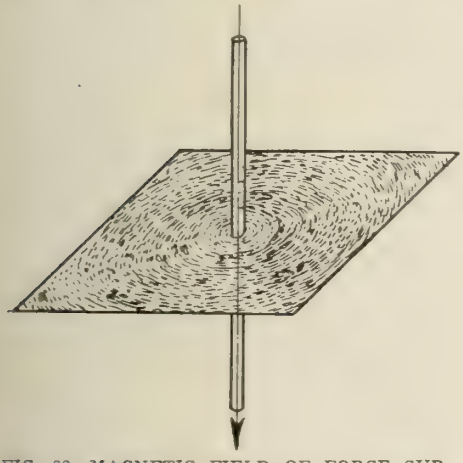


FIG. 22—MAGNETIC FIELD OF FORCE SURROUNDING A WIRE CARRYING CURRENT AS SHOWN BY IRON FILINGS.

This will give rise to the suspicion in our minds that the electric current exerts some kind of force upon the field of space around the wire through which it is passing and from the behavior of the filings we will naturally conclude that some form of magnetic force is present. This is the case, although a difference exists between the magnetic fields of magnets and wires. In a permanent bar magnet the lines of force emerge at one end and enter at the other, while in a wire carrying current the lines of force surround the wire.

If instead of filings we use a compass as in Fig. 23 and move it around the wire on its cardboard support we will find that the needle changes its position and any point on it will trace a circle around the wire, the needle always pointing in a direction tangent to a circle drawn through its centre. Examination will show that the magnetic force gets bigger as the current increases, disappears when the current stops and reverses if the current is reversed.

Direction of the Magnetic Flux Due to Current

From the behavior of the needle when the current is reversed, it may be suspected that the direction of the current has quite an effect on the direction of the magnetic lines of force surrounding the wire. In Fig. 23 if the wire is carrying current in the direction indicated by the arrow at its lower end, then the needle will come to rest with the north pole pointing out at the observer. If the current is now reversed and made to flow up through the wire instead of down, the compass needle will immediately swing around and point with its north pole away from the observer. In the first case the lines of force are said to travel around the wire in the direction shown by the arrows on the two circles.

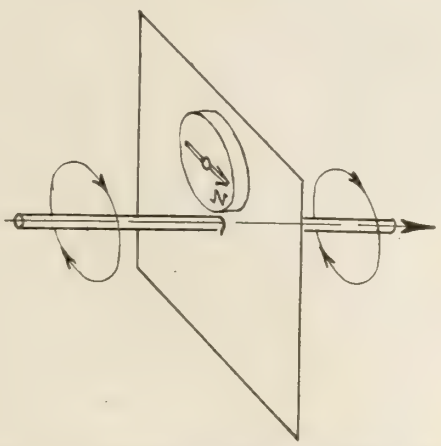


FIG. 23—MAGNETIC FIELD OF FORCE SURROUNDING A WIRE AND DIRECTION OF FLOW.

The direction which the lines of force will take may be easily remembered by thinking of a right hand nut and screw. If the nut is turned over to the right on the screw it will travel away from the observer. The direction of rotation of the nut corresponds to the direction of the magnetic lines of flux, while the travel of the nut along the screw indicates the direction of current flow.

The relations between current flow and magnetic flux are also easily remembered by another simple little rule shown in Fig. 24.

The right hand is supposed to grasp the wire with the thumb extended along it in the direction in which the current is flowing. The fingers of the hand will then wrap around the wire in the direction in which the magnetic flux is travelling.

The Solenoid

If we take a coil of wire and thread it through a piece of cardboard as shown in Fig. 25, then pass a current through it and sprinkle iron filings on the cardboard, a figure will be obtained much as is shown. The filings will arrange themselves in an orderly pattern. Some of them will group themselves in little circles around each individual wire, but the majority of them will group themselves in lines passing around all of the wires in through along the axis of the coil and around to the outside. It will be seen that the figure has some resemblance to that made by a permanent bar magnet and we have actually produced a magnet though perhaps weaker and of no consequence. If the current is interrupted the filings will lose their orderly arrangement and will show no indication of lines of force.

Magnetic poles are formed in the same way as with the permanent magnet, at the ends of the coils. The reason for this may be better understood from Fig. 26. Here a small coil is shown in section with the top part cut away. The current is travelling in the direction indicated by the arrows and the magnetic lines of force around each wire, indicated by the circles have the directions shown. In the top half of the diagram the flux will travel clockwise since the current is flowing away from the observer, while in the bottom half they will be seen to travel in the opposite or counter-clockwise direction since the current is flowing towards the observer. By applying the right hand rule given above this will be seen to be so. Instead of the magnetic flux, due to each wire passing around the individual wire, the greater portion of it will flow around all the wires and we will thus have a strong stream of magnetic flux passing through the coil emerging at one end and entering again at the other.

If a bar of iron is placed in the centre of the coil of wires shown in Fig. 25 the magnetic effect will be found to be very much increased. As stated in the last issue of Power House, some materials have the property of offering much less resistance to the flow of magnetic flux than others. Iron in some of its forms is one of the best conductors for magnetism and its insertion into the magnetic circuit lowers the magnetic resistance appreciably. Thus supposing we have the same coil and the same flow of current through it the force causing the flow of magnetic flux will be the same, but since the magnetic resistance,

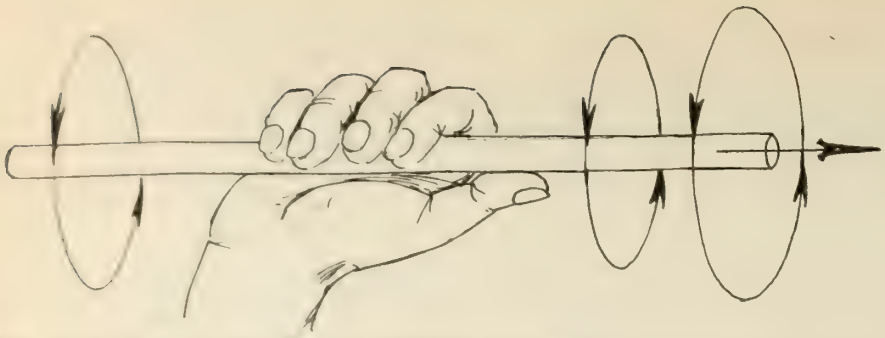


FIG. 24 RULE FOR DETERMINING DIRECTION OF MAGNETIC FLUX AROUND WIRE CARRYING CURRENT.

if it may be called such, will be much less, a greater effect will be produced.

There is a limit to the amount of magnetic flux which can be forced through iron or rather it becomes more and more difficult to increase the strength of any electro-magnet after a certain point is reached. In many problems it is important to be able to express the amount of flux as a numerical quantity and a unit has been chosen for this purpose called the Maxwell. This name is somewhat out of use at present and instead of saying so many Maxwells, it is more usual to say so many lines of force. The flux density or the strength of the magnetic field is measured in lines of force per square centimeter or per sq. inch. This unit finds considerable use in the design of electrical apparatus. Iron and all other substances which are magnetic have the peculiarity that when magnetized to a high flux density the permeability or capacity for further magnetization greatly decreases. Under such conditions the magnetic material is said to be approaching saturation and with very high flux density is said to be saturated. Saturation is rather an indefinite term. With good wrought iron or steel it would be reached at something like 20,000 or more lines per sq. centimeter, while in cast iron it would be in the neighborhood of 8,000.

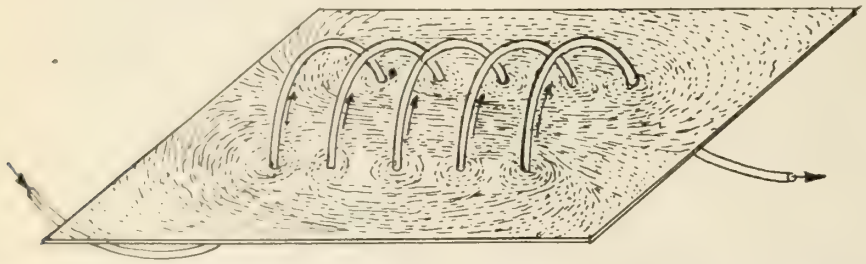


FIG. 25—THE MAGNETIC FIELD OF FORCE SURROUNDING A SOLENOID AS SHOWN BY IRON FILINGS.

In Fig. 24 a method of determining the direction of flow of magnetic flux around a wire carrying current was shown. Fig. 27 shows a corresponding method of determining the polarity of solenoids or electro-magnets. In this case the coil of wire is grasped by the *right* hand with the fingers pointing in the direction of current flow. The thumb extended along the coil will point in the direction of the magnetic flux and since the flux flows out of the north pole the thumb will also point towards the north pole of the magnet or solenoid.

In the next issue of Power House the elementary theory of dynamo-electric theory will be discussed.

Uehling Instrument Co., 71 Broadway, New York, has just issued Bulletin No. 111 describing style U Uehling CO_2 equipment. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously, up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Neglect of this factor is costing power plant owners heavily. Among the notable features of the new machine are speedy action, resulting from a new form of aspirator, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front CO_2 indicator, which guides the fireman, while the CO_2 recorder, installed in the chief engineer's or superintendent's office, makes a continuous (not intermittent) record, showing all changes in boiler adjustments that are conducive to either waste or economy.

The Uehling Instrument Co., 71 Broadway, New York, manufacturers of fuel economy equipment, announces that it is now being represented in the New England states by the Smith Engineering & Supply Company, 89 State street, Boston, Mass., manufacturers' agents and engineers, specializing in power plant equipment. Mr. S. W. Smith, president of the latter company, was until very recently associated with the Uehling Instrument Company with headquarters in their New York office.

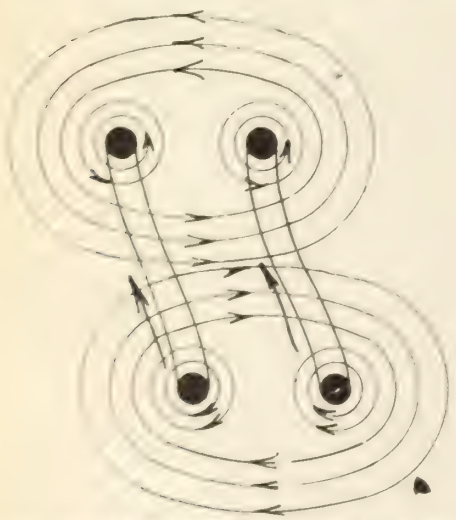


FIG. [illegible] ELEMENTARY SOLENOID SHOWING LINES OF FORCE.

FIG. 27 POLARITY OF SOLENOID OR ELECTRO MAGNET.

Starting Properties of D. C. and A. C. Motors

The Various Characteristics of Different Types of Motors Discussed in Relation to Their Starting Properties—Paper Read Before the London Branch of the Association of Mining, Electrical Engineers

By O. L. RECORD

ONE has often to decide what type of motor is best suited for a particular purpose, and consequently a few notes on motor characteristics, with special reference to their starting properties, may be useful.

Direct-Current Machines

(a) Series-wound.—In this type of machine, as the field is excited by the main current, an increase of load increases the strength of the field, and so slows the machine down, and vice versa.

As the torque is proportional to the product of the armature current and field strength, the torque of a series motor would always vary directly as the square of the current were it not that the magnetic circuit becomes saturated above a certain point. In such a theoretical case, doubling the current would give four times the torque, and, at the same time, the speed would be halved, so that the motor would deliver double the power at half the speed. In practice one would obtain considerably more than double the torque and rather more than half the speed.

The curves in Fig. 1 give the relation between current, torque, speed, and power on a typical motor of this kind. It will be seen that the motor automatically adjusts itself to the load, taking a heavy load at a low speed and a light load at a high speed. At starting the torque will be proportional to the current taken, the motor giving full-load torque with full-load current, the latter being limited to the value required by a series starting resistance.

(b) Shunt-wound.—In this type of motor, as the field is excited by a circuit separate from that of the armature, the speed is independent of the armature current except for a slight drop on heavy loads, due to armature resistance voltage drop, and it depends merely on the field current, which again is proportional to the supply voltage. By varying the excitation the speed can be altered quite independently of the load. For a constant field the torque is proportional to the armature current.

Fig. 2 gives curves of torque, speed, and power for this class of motor, and it will be useful to compare this with Fig. 1. In this class also the starting torque will be proportional to the current taken, the motor giving full-load torque with full-load current, and the latter being limited to any desired value by means of a series starting resistance.

(c) Compound-wound.—The effect of the compounding is to give increased starting torque for the same starting current, but at a somewhat lower speed, depending on the proportion of series turns, and also to increase the momentary overload capacity of the machine. On the other hand, the difference in speed between no-load and full-load will be increased.

If even greater constancy of speed is required than that given by a shunt machine, this may be obtained by having a few turns of series winding arranged in opposition to the shunt winding, so that as the load is increased the field is weakened and the speed kept up. This arrangement, however, makes the starting up more difficult, and also decreases the overload capacity of the machine.

Figs. 3 and 4 give the torque, speed, and B.H.P. curves for a compound-wound motor, with cumulative compounding and differential compounding respectively.

Alternating-Current Machines

(a) Polyphase, Asynchronous, or Induction Motors.—In motors of this class the speed is constant except for a slight drop due to slip, amounting to not more than 5 per cent. at full load, and depends solely on the frequency of the supply and the number of poles for which the motor is wound.

The torque varies as the current taken from the line, and both are proportional to the square of the applied voltage. It is important to bear this in mind, for if the voltage only drops as much as 10 per cent., the torque will drop as much as 19 per cent., perhaps sufficient in the case of a heavy load to throw the machine out of step and bring it to a standstill.

Curves of torque, speed, and B.H.P. for a typical motor of this class are given in Fig. 5.

In order to deal with its starting characteristics, it will be necessary to subdivide this class of motor as follows:

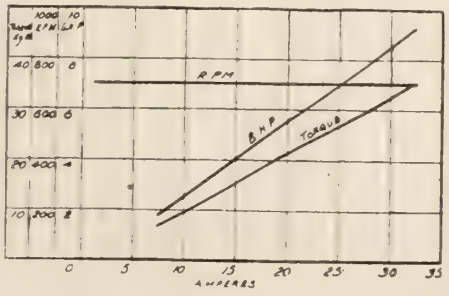
1. Squirrel-cage Type.—These motors may be started in the following ways: First, small motors may be switched direct on to the mains, and will then give a starting torque of about double full-load torque with about six times the normal full-load current. This method of starting is naturally not advisable except in the case of very small machines starting light.

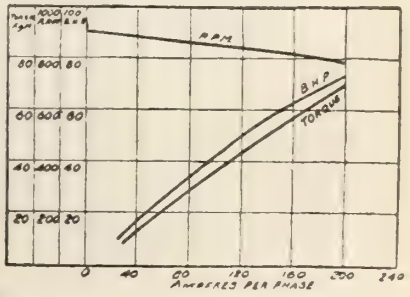
Secondly, by means of stator rheostatic starters. The effect of inserting resistance in the stator is to reduce the voltage across the stator windings, and limit the starting current; but this, unfortunately, results in reducing the torque to a much greater extent—namely, as the square of the voltage, as explained above. If sufficient resistance is inserted to limit the current to even as high a value as two and a half times full-load current, yet the motor will develop only 10 to 25 per cent. of full-load torque; a loose pulley or clutch is therefore necessary for starting in such cases.

Thirdly, by means of star-delta switching in the case of three-phase and series-parallel switching in the case of two-phase motors: If a three-phase motor is started in this way the voltage across each phase winding at starting is reduced to about 0.6 time the running voltage. Consequently the starting current taken will be about 0.36 of the direct-connected starting current, or about two and a half times the normal full-load current. At the same time, the starting torque will be reduced to about 0.36 of full-load torque.

Fourthly, by means of an auto-transformer starter or compensator. The effect of using this type of starter is exactly similar to that obtaining with star-delta starting. Thus the direct-connected starting current and the starting torque are reduced approximately as the square of the reduction in the starting voltage. The voltage tappings very usually employed are 0.5, 0.6, and 0.75 of the line voltage, corresponding to motor starting currents of 1.5, 2.5, and 3.5 times full-load current, and starting torques of about 0.25, 0.36, and 0.56 of full-load torque. The corresponding line currents will be approximately ¾, 1½, and 2½ times full-load current.

2. Slip-ring Type.—Wound-rotor machines are started by inserting resistance in the rotor circuit to limit the starting current to any desired value. When started in this way full-load torque will be obtained with one to one and a quarter time normal full-load current. The relation between torque and current for





other values of the latter is roughly as follows:

[illegible] of full-load current gives 25 % of torque.
[illegible] of full-load current gives 33 1-3% of torque.
65% of full-load current gives 50 % of torque.
70% of full-load current gives 66 2-3% of torque.
80% of full-load current gives 75 % of torque.

It will therefore be seen that, if a starting torque of 25 per cent. or more of full-load torque with not more than full-load current is required, a slip-ring machine is essential.

3. Self-starting Type.—There is another class of polyphase induction motor having all the advantages of a squirrel-cage machine, but which will start up satisfactorily with a high starting torque without the use of any auxiliary starting apparatus. In motors of this type the rotor winding is composed of two or more sections, which are normally connected so as to give a high resistance at starting, the connection being automatically changed to give a low resistance when the motor has reached 70 to 80 per cent. of its normal speed, by means of a switch operated by a centrifugal governor.

In one motor of this class, one-third of the rotor copper is in circuit at starting, the remaining two-thirds being open-circuited and connected to a short-circuiting device, which operates when a predetermined speed has been reached.

In another motor of this class the rotor winding is in two or three sections, which are connected in series for starting and in parallel by means of the governor switch when up to 70 to 80 per cent. of the normal speed.

Motors of this class are normally designed to give at starting about 2½ times full-load torque with two to three times full-load current, depending on the size, make, etc. Compare this with the starting torque of about 70 per cent. of full-load torque for three times full-load line current of a squirrel cage motor auto-transformer starter.

If desired, the starting current taken by these motors can be reduced by means of any of the starters employed with squirrel-cage motors, but, of course, with a corresponding reduction in starting torque.

As these motors run as ordinary induction motors, the running characteristics are exactly similar to the latter class of machine.

(b) Single-phase Motors.—1 Induction Type.—As in the case of polyphase induction motors, the speed of these machines depends merely on the frequency of the supply and the number of poles for which the machine is wound, whilst the torque is approximately taken, that is to the load. The characterization curve is similar to those of polyphase machines. Owing to the fact that the field produced by a single-phase current is oscillating and not revolving, as in the case of two or three-phase, a single-phase motor has no inherent starting torque, the latter only being produced when the rotor revolves; consequently an auxiliary or starting phase with a phase-splitting device (consisting usually of a non-inductive resistance in the main winding and a choking coil in the auxiliary winding) has to be provided. Even then the starting torque is but feeble, and a loose pulley must always be employed.

These machines are built of the squirrel-cage and slip-ring types. A squirrel-cage machine will not give more than 10 to 15 per cent. of full-load current. The starting qualities of the slip-ring type are rather better, but even in this case a starting torque of not more than 20 per cent. of full-load torque will be obtained with 100 to 125 per cent. of full-load current.

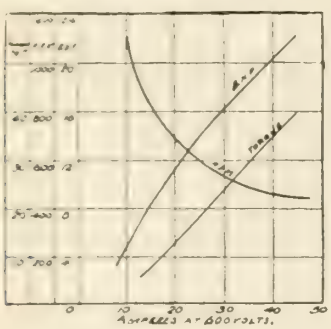


FIG. 1.

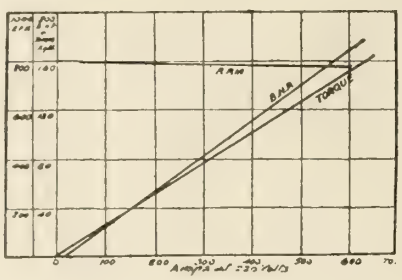


FIG. 2.

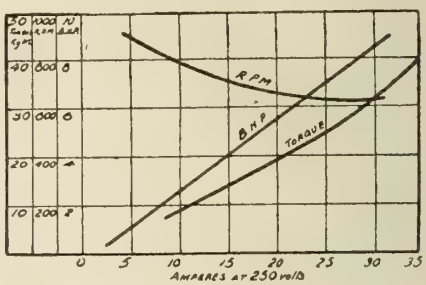


FIG. 3.

2. Repulsion Induction Type.—These machines are really repulsion motors as far as construction is concerned, and start as such, but are fitted with a centrifugal governor which short-circuits the commutator and lifts the brushes when the motor has got up to speed, so that it continues to run as an ordinary single-phase induction motor. The running characteristics are therefore exactly similar to the latter type, but as against the very feeble starting torque of the split-phase motor they have a starting torque of about 2½ times full-load torque with about 2½ times normal full-load current.

If it is necessary to limit the initial current taken from the mains to a lower value, a plain series starting resistance, such as is used with a direct-current motor, is employed. This tends to raise the power factor so that full load current at starting will give about 1 to 1½ times full-load torque.

ELECTRICALLY DRIVEN PUMPS.

At a meeting of the Institution of Water Engineers, held at Birmingham, Mr. C. F. Bekenn, A.M.Inst.C.E., contributed a paper on "The Application of Turbine-pumps to Water Supply." In the course of the paper the author remarked that while turbine-pumps could be driven by any type of prime mover, he placed the electric motor in the first place as regarded efficiency and convenience. The installation costs, including foundations, were low, and the space occupied was small. The pump and motor required very little attention, as the bearings were automatically lubricated with oil-rings. Low installation costs permitted the sets to be conveniently distributed. They were easily started up, and could also be operated from a distance or automatically stopped and started, either by varying levels in the reservoir or by varying pressures between pre-determined limits. The alternating-current motor was preferable to the direct-current machine owing to the absence of a commutator, and most of the installations at work were driven by A.C. motors. If a heavy current rush on starting was permissible, it was advisable to install squirrel-cage motors, as the turbine-pump, owing to its low-starting torque, could easily be started up by this type of motor. One point that had to be noted was that the slip between synchronous and asynchronous speeds could not be exactly determined, and might vary as much as 2 to 4%. The B.H.P. required to drive the turbine-pump varied as the cube of the speed, so that should the slip be less by, say, 2% than the makers' original estimate, the B.H.P. would be considerably increased, with a proportionate increase of water. For squirrel-cage motors, auto-transformer starters of the oil-immersed type should be installed, with no-volt and overload release on the three circuits, these operating in the stator circuit. The starter consisted of a transformer with tappings on the windings, of varying percentages of the line voltage. The tappings should be selected as best suitable for the starting torque, and as that was not more than 50% of full load torque, a low percentage, say, 25 or 30%, was sufficient. The automatic features were arranged in the "running" position only, because in the "starting" position they would at once break the circuit owing to the rush of current, which was generally two or three times the ordinary running current. This type of starter required only three terminals on the motor and six on the starter—namely, three for the motor and three for the line. In cases where low starting currents were necessary, slip-ring

motors should be installed, as those would start up with 50 per cent. of full load torque using normal running current. With reference to motor terminals, trifurcating boxes were recommended as providing an extremely neat finish and effectively enclosing all the live parts. In large pumping-stations, where the current had to be carried some distance and the motor-power was at least 150B.H.P., the motors could be wound for 6,000 volts, and so dispense with transformers. For motors of less than 150B.H.P. a lower voltage was necessary on account of the difficulties of insulation in the coil windings.

Proceeding to discuss the relative costs of steam and electric pumps, the author gave several examples as showing that economy was on the side of the latter. Thus, the City of Hereford had three electrically driven pumps working off a three-phase, 50-cycle circuit, two sets delivering 60,000 gals. per hour, and the other set delivering 20,000 gals. per hour, against a total lift of 120 ft. in each case. The costs, as recently determined, showed that with electricity at 0.75d. per unit, the cost of electric pumping was 0.5d., as compared with 0.426d. per 100,000 gals., the cost of steam pumping. Those figures included men's wages, lubricating oil, waste, etc. The Newbury District Water Company, early in the year 1912, made careful tests of its compound condensing steam pumps, and of its electric pumps. The latter were driven by direct-current motors, one set having a capacity of 30,000 gals. per hour against 185 ft. lift, one set 20,000 gals. per hour against 150 ft. lift, and a further set 3,000 gals. per hour against 164 ft. The 1912 costs worked out at 1.18d. per 100,000 ft.-gals. for steam, as against 0.957d. for electrically driven pumps, but for 1920 the figures are 2.61d. and 1.576d. respectively. The Chester Waterworks Co. had installed a Diesel engine and dynamo supplying power to drive turbine pumps built by Sulzer and the Rees Roturbo Company, at two separate stations connected by cable. The costs, including all transmission losses and "shut-downs" due to interruption in working consequent on erection of additional plant, came to 0.657d. per 1,000 gals. 100 ft.

Advantages of Flat Furnace Arches

THE recent development of flat arches to a point of distinctive serviceability for boiler furnace construction lies in many cases in simplified design and besides offers greater convenience in the matter of routine repairs. Frequently the design of furnaces calls for reflecting surfaces at various angles and in some special cases some advantages are to be gained in using curved surfaces. The use of sprung arches limits the latitude of construction in these respects and thus many possibilities for furnace improvement go begging.

Also in natural draft furnaces wherein the construction is more or less standard, the support of the necessary curtain wall requires the construction of a separate sprung arch for this purpose although this arch has no function in the combustion of the fuel itself. In designs calling for step-up arches the construction is further complicated. On the other hand flat suspended arches have answered to a considerable extent the criticisms of the usual construction in two respects in particular; viz.: (1) the design eliminates a quite usual source of air leakage into the furnace through the clearance space between arches, and (2) the gaining of increased available headroom which, in the case of forced blast stokers is particularly desirable. In other minor respects flat arches have overcome the effect of sag in sprung arches, in which case no real effective seal can be made either be the "keying up" with the curtain wall arch, or between the curtain wall and roof, as is the case on B. & W. or similar type boilers.

In the matter of routine repairs of sprung arches, the rebuilding of a bock ring at the fire end requires that the new brick be bonded with the old, and this is rather a difficult matter to do without subsequent cracking. Besides the "keying up" with the curtain wall support arch in place is by no means an easy matter. Here again the flat suspended arch offers convenience of repairs with an increased amount of salvage of the used materials.

As to the proper position, length and pitch of fire arches, it can be stated that there is no exact or precise method of determination, thus giving rise to much diversity of opinion as to these matters among engineers. The only reliable guide is trial and experiments; there are, however, many fundamental principles from a combustion standpoint which determine these factors with some practical degree of accuracy, but too frequently the overall design of boiler and furnace is such that the best proportioning is interfered with, particularly in the matter of the position of the grate with respect to the boiler. In standard construction the art has developed certain relations, which, from the results of actual test and practice appear to offer the most economical results. It is proposed to consider a few of these in this instance.

The function of an ignition arch is to produce as intense a heat reflection at the point of ignition as is possible. The temperatures obtained at this point are, of course, largely dependent upon the sizing and general character of the coal, but most of all to the air supply over this area. In the case of natural draft the temperature possibilities are limited mostly on account of the latter reason, while in forced draft stokers the problem of ignition is simple and controllable. On natural draft a number of trials have shown that the most effective distance between the ignition arch and the fuel bed is from 6 in. to 7 in. and that there is no particular advantage in extending the length of this surface beyond 12 inches insofar as benefiting combustion is concerned. There are, however, many instances where mechanical difficulties have necessitated a departure from this practice. Under forced draft conditions the larger volume of gases requires a greater space between the fuel bed and ignition arch, it being approximately proportional to the amount of increased fuel burned per square foot, per hour. The figures given above apply to a coal rate of 40 lbs. free burning coal per square foot per hour and an 8 in. fuel bed.

The height of the main or fire arch should be such that the intensity of the heat reflection is sufficient to insure continuous combustion the full length of the grate, and in addition provide sufficient volume for the intimate mixture and easy flow of gases of combustion. It is thus evident that the height above the fuel bed is a function of the coal rate per square foot per hour. Under normal natural draft coal rate of 40 lbs. the most effective point is shown by experiment to be between 13 and 20 inches at the front end. However, an arch constructed in accordance with this minimum require that the pitch be such that the increasing sectional area be proportional to the increasing flue gas volume. This steep pitch does not permit of an intimate mixture of gases, particularly over the area of destructive distillation, and unburned hydro-carbons and smoke are the result. These objectionable conditions are removed by raising the front end to the maximum height and using only a slight pitch of about 1 in. per foot. Under forced blast conditions additional furnace volume is required not only on account of the increased coal rate of 60 lbs., excellent conditions were obtained with the main arch 4 ft. above the grate.

Theoretically, the arch projection which gives 100 per cent. over the grate should be correct, but a practical design on this basis is obviously impossible. Good practice calls for a 65 per cent. projection, which gives the maximum length possible, while at the same time providing sufficient exit area from the furnace. Except for this limiting factor and easy flow of air through the fuel bed at the ignition arch, the longer the arch the lower the carbon content of the ash. The disposition to smoke is also accordingly reduced. In the case of forced blast stokers where ample furnace volume is provided, arches of this length are not required as far as combustion of fuel on the grate is concerned.

In general, it can be said that in furnace design the type of boiler and its position with respect to the grate in many cases required deviation from the

(Continued on page 385)

A Course of Instruction for the Graded Certificate

We Will in This Course Go Through the Mathematical and Theoretical Work to Cover Every Grade of Certificate Issued by the Ontario Board

By T. H. FENNER

IN our last article we arrived at the leading dimensions of a boiler to give 100 h.p. at the standard rating of 34½ lb. water from and at 212 deg. per horse power. These we found to be 72 in. in diameter by 18 ft. long. As the pressure determined on was to be 125 lbs. per square inch we must decide on the thickness of shell and type of riveted joints on the longitudinal seam to carry this pressure, with due allowance for the factor of safety. This factor of safety must be determined by the rules given in the Ontario Government Act, and will vary according to the conditions under which the boiler is built. Following are the rules as given in the handbook issued by the Government.

Factors of Safety

Boilers well designed, well constructed, and made of good material, should be allowed a higher working pressure than boilers inferior in any of the above respects, and unless this is done the superior boiler is placed at a disadvantage and the use of good workmanship and material will be discouraged. To provide for the above, the following rules regarding factors of safety for cylindrical boilers and cylindrical parts of boilers have been adopted.

When cylindrical shells of boilers are made of the best material either in iron or steel with all holes drilled in place from the solid plate, the plates afterwards taken apart and the burrs removed, and all longitudinal seams fitted with double butt straps, each at least ⅝ the thickness of the plates they cover, the seams being double riveted with rivets having an allowance of not more than 75 per cent. over the single shear, and having the circumferential seams constructed so that the per cent. is at least one half that of the longitudinal seam and provided that the boiler has been inspected by inspectors authorized by the act during the whole period of construction in accordance with these regulations, then 4.5 may be used as a factor of safety, but when the above conditions have not been complied with the additions to the following scale must be added to the factor of safety according to the circumstances of each case.

To be added to the factor of 4.5.

A .10 Holes in longitudinal seams, fair and good, but drilled from solid out of place after bending edges of plates.

B .20 Holes in longitudinal seam, fair and good, drilled from solid out of place before bending edges of plate.

C .20 Holes in longitudinal seams, fair and good, punched after bending edges of plates and reamed after assembling.

D .30 Holes in longitudinal seams, fair and good, punched before bending edges of plates and reamed after assembling.

E .07 Holes in circumferential seams, fair and good, drilled from solid out of place after rolling plates.

F .10. Holes in circumferential seams, fair and good, drilled from solid out of place before rolling plates.

G .10 Holes in circumferential seams, fair and good, punched after rolling plates and reamed after assembling.

H .15 Holes in circumferential seams, fair and good, punched before rolling plates and reamed after assembling.

I .70 Longitudinal seams, if double butt straps are not fitted and the said seams are lapped and double riveted.

J .50 Longitudinal seams, if double butt straps are not fitted and the said seams are lap and treble riveted.

K .60 Longitudinal seams, if only single butt straps are fitted and the said seams are double riveted.

L 1.00 Longitudinal seams, when any description of joint is only single riveted or when double straps are used and only one row of rivets in double shear.

M .50 Holes or rivets in longitudinal seams if not fair and not good.

N .20 Holes or rivets in circumferential seams not fair or not good.

O .40 Holes in any seams not properly spaced in crossing.

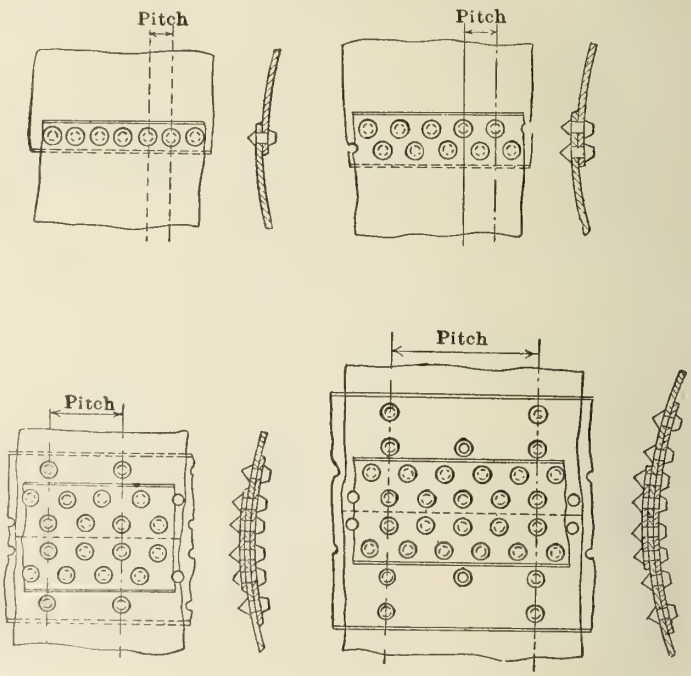
P .40 When material is doubtful and not properly certified in accordance with regulations.

Q .50 If joints are not close fitting the plate being open when boiler is finished or workmanship unsatisfactory.

R .50 If boiler has not been inspected by inspectors authorized by the act during the whole period of construction in accordance with these regulations.

The inspector is allowed some latitude according to his judgment of the circumstances in appying these regulations.

In designing a boiler, the highest factor of safety will be aimed at. This means that the best possible type of joint must be used on the longitudinal seam and that workmanship and material must be good. Before going any further we will therefore discuss the different types of joints.



TYPES OF RIVETED JOINTS

Kinds of Joints

The efficiency of a riveted joint is expressed always as a percentage of the strength of a solid plate. When holes are drilled or punched out of a plate to allow of riveting, the plate is weakened by the amount of metal cut out. If we have a plate of one square inch section, and remove .25 square inches in drilling, the section remaining is only .75, and the resistance of the plate to stress will be only 75 per cent. of its original resistance. This would represent what is known as per cent. of plate strength to solid plate. This is only one factor. The second factor is the proportion that the strength of

the rivets bears to the strength of the solid plate. This will depend on the diameter and number of rivets in the unit section of plate considered, and is also expressed as a percentage. We shall consider the means of arriving at these efficiencies shortly.

There are several styles of riveted joints, and two distinct classes. The lap type of joint is so called because it is made by lapping the edges of the plate over each other and riveting them together. The second type is known as a butt joint and is made by bringing together the edges of the plates to be joined and placing a broad plate over them, riveting all three plates together. In many cases two cover plates are used. These two types of joints are subject to various modifications. Thus a lap joint may be single, double, or treble riveted and the rivets may be placed in regular rows or in staggered rows, known as chain or zig-zag riveting. The butt strap joint may be made with one or two straps, with equal or unequal straps, with double, treble or quadruple riveting. The type of joint selected will depend upon the pressure to be carried, cost of manufacture and rules of the province in which the boiler is to work. The cut here shown illustrates the type of joints mentioned above.

To Find Efficiency of Joint

The efficiency of a riveted joint varies with the diameter of rivets, pitch of rivets, number of rivets in a pitch, and the thickness of the plate. In considering riveted joint efficiency, the unit of plate area considered is always contained within a pitch or between the centre lines of two adjacent rivets. Where there is more than one row of rivets the pitch of the rivets in the outer row is taken. We will explain each type as we come to them. The most simple is of course the single riveted lap joint. Suppose we have a plate of 5-16 inch in thickness, and with ⅝ rivets pitch 2 inches. We have to consider the strength of the joint as compared to the solid plate. We will consider the plate to be of 60,000 lbs. tensile strength. We shall therefore have a section, before any drilling is done, of 2 x 5-16 = ⅝ square inches. This section will have a resistance of 60,000 x ⅝ = 37,500 lbs. Now, after drilling, the amount of metal removed will be in diameter just equal to the diameter of one rivet because in the section we are considering there will be just half a hole on each side. A glance at the sketch which shows the pitch of line passing through the centre of rivets will make this clear. Therefore the amount of metal removed will be equal to the diameter of one rivet multiplied by the thickness of the plate, or

$\frac{5}{8} \times \frac{5}{16} = \frac{25}{128}$. This amount subtracted from the original area will give the section remaining, and if this remainder be divided by the original section we will have a fraction, representing the proportion of original section remaining. To express this as a percentage we multiply by 100. Now to follow out the procedure step by step.

Let

P = pitch.
d = diameter of rivet.
t = thickness of plate.

We have a plate section of pitch P, and thickness t, the area being Pt. The rivet area will be equal to dt, so that when the holes are drilled we shall have

$$Pt - dt = P - d$$

the t on each side cancelling out.

The proportion of plate section remaining is $\frac{P-d}{P}$ and the percentage of plate to solid plate is $\frac{P-d}{P} \times 100$. Substituting figures, we get

$$Pt = 2 \times \frac{5}{16}$$

$$dt = \frac{5}{8} \times \frac{5}{16}$$

$$Pt - dt = 2 \times \frac{5}{16} - \frac{5}{8} \times \frac{5}{16}$$

$$P - d = 2 - \frac{5}{8}$$

$$\frac{P - d}{P} = \frac{2 - \frac{5}{8}}{2}$$

$$\frac{P - d}{P} \times 100 = \frac{2 - \frac{5}{8}}{2} \times 100$$

$$= \frac{2 - .625}{2} \times 100$$

$$= \frac{1.375}{2} \times 100$$

$$= 68.75$$

So that the proportion of plate strength to solid plate is 68.75 per cent.

This formu'a is always used, and may be set down

$\frac{P - D}{P} \times 100 =$ per cent. of plate strength to solid plate.

In the Ontario regulations the plate efficiency is symbolized by the letters Kt, so the formula is

$$\frac{P - D}{P} \times 100 \text{ Kt}$$

The next point to consider is the efficiency of the rivets in the joint. This is the proportion that the area of the rivet in the pitch limit bears to the unit section of plate. As rivets are not as strong in resisting shearing stresses as they are in resisting tensile stresses, an allowance must be made for this difference. The Ontario regulations use the constant C, and this is expressed

$$C = \frac{\text{Shearing strength of rivets}}{\text{Tensile strength of plate}}$$

C may be taken as

.85 for iron rivets in iron plates
.70 for steel rivets in steel plates.
.65 for iron rivets in steel plates.

In the joint we are considering there is but one rivet in the pitch, and as there are but two plates which the rivets pass through they are in single shear. We will then have an area of d x d x .7854, divided by the area of the unit section, which is P x t. This is expressed in the formula:

$\frac{a \times n}{P \times t} \times C \times 100 =$ per cent. of rivets' strength to solid plate.

So we have

$$\frac{5 \times 5 \times .7854 \times 1 \times 16 \times C}{8 \times 8 \times 2 \times 5} \times 100 = \text{Ks}$$

This worked out becomes, if we take C as .85

$$\frac{5 \times .7854 \times 85}{8} = 41.72 \text{ per cent.}$$

If we neglected the constant C we would get about 49 per cent. This lowest percentage is the one used in calculating the working pressure of the boiler. In our next article we will consider the strength of riveted joints of more complicated design.

ADVANTAGES OF FLAT ARCHES

(Continued from page 283)

principles of good practice. With boilers of the B. & W. type or Heine type where sufficient headroom obtains, the opportunities for flexible design are not interfered with, but in the case of Stirling, Conolly and similar types, practical conditions have to be overcome, and in many cases at the expense of efficiency. It is obviously quite difficult to formulate a code of furnace practice to cover all special conditions, but on the other hand those principles established by usage and corroborated by experiment should offer the furnace designer considerable insurance against failure.

Many engineers are at the present time prone to accept the fantastic and gamble with untried principles. Again there are others who opine that the mere changing of a detail is a cure for all ills. The best guide after all that can be said, is trial and experiment.

A. S. M. E. MEETING

The 1920 annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 West 39th Street, New York City, from December 7 to December 10.

Sessions will be held on the subjects of appraisal and valuation, and the application of engineering to woodworking.

The newly founded profession sections on management, power, fuels, machine shop, railroads and textiles will also conduct sessions to consider the vital problems in their field. In addition a number of valuable papers will be presented at general sessions.

A memorial session for Dr. Brashear is planned, as a fitting tribute to his life and work.

The Open Type Locomotive Feed Water Heater

The Theory and Practice of Feed Water Heating by This Type of Heater is Discussed by the Author in a Paper Read Before the A.S.M.E.

By THOMAS C. McBRIDE

THE use of feedwater heaters on locomotives dates back to the beginning of the locomotive itself. There are records of the application of an "open" or "injection" type heater to a locomotive in England in 1827, and an English patent of 1828 describes a tubular heater for the same purpose. Ross Winans of Baltimore applied tubular heaters to two types of Baltimore & Ohio railroad locomotives in 1836. It is worthy of note that the desirability of the feedwater heater for the locomotive was recognized at these early dates, although it must be appreciated that the advantages possible at that time were proportionately greater than at the present time because of the low steam pressure then in use.

There is much of interest in the history of locomotive feedwater heating in a paper, Feedwater Heaters and Their Development by J. Snowden Bell which was presented at the fiftieth annual meeting of the American Railway Master Mechanics Association, in June, 1918. Every conceivable type of heater and all possible sources of heat, even the hot ashes, seem to have been proposed or tried, and in view of the amount of study that has been given to the subject it seems rather remarkable that locomotive feedwater heating is not now in more general use. Possibly the reason lies in the fact that it is only in comparatively recent years that the essentials of heater performance and pump operation have been understood. Furthermore the small size of the locomotives formerly in general use limited the saving per locomotive, and the general adoption of the injector, because of its simplicity and convenience, rendered feedwater heating impossible, for injectors heat the water which they use to such an extent by live steam that there is little or no opportunity for further heating.

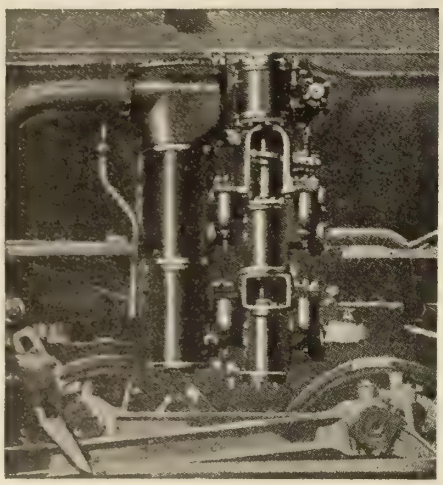


FIG. 1—PUMP AND HEATER APPLIED TO MIKADO LOCOMOTIVE.

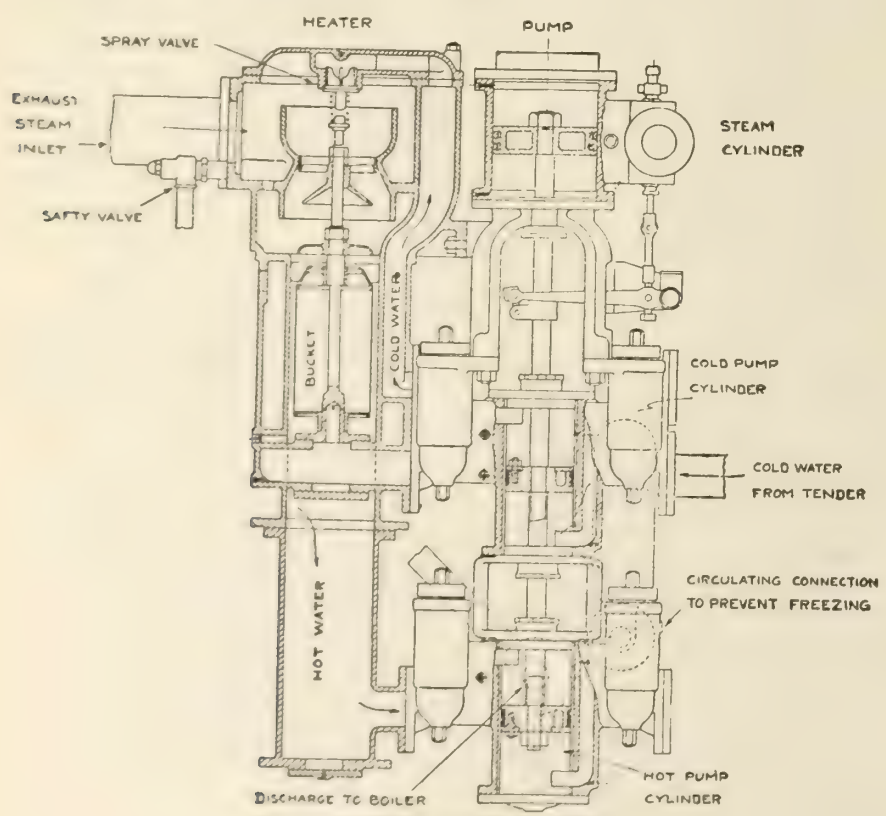


FIG. 2—SECTION OF THE HEATER.

There are two possible sources in a locomotive from which otherwise waste heat may be obtained to heat the feedwater: (a) the waste gases in the smokebox or stack, (b) the exhaust steam. Stationary practice with economizers indicates the waste-gas heaters cannot be supplied with cold water because the accumulation of condensation and soot on them seriously interferes with their efficiency. It is, therefore, necessary to turn to the exhaust steam for the source of heat and to develop this type of heater first, leaving the waste-gas heater for later development as may be found either necessary or advisable.

The exhaust steam heater may be either of the open or injection type in which the exhaust steam comes into direct contact with the cold feedwater so that the water condensed from this exhaust steam is added to and mixed with this feedwater; or, of the closed or surface type in which the heat from the condensation of the exhaust steam passes to the feedwater through thin sheets of metal, generally in the form of thin brass tubes. Practically all of the development work to date that has been at all successful has considered only the surface type. There are a great many heaters of this type in service in Europe, but there are objections to it for locomotive use. It is a complex and delicate structure; it also wastes the water condensed from the exhaust steam with its heat or raises complications as to saving it, and it requires enough exhaust steam to heat all of the feedwater. On the other hand, the open or injection type of heater necessarily recovers both the water condensed from the exhaust steam and its heat so that both are returned direct to the boiler with the water taken from the tender. Less water is therefore taken from the tender and less exhaust steam is required for the heating.

Description of a New Type of Heater

With these thoughts in mind, the author has devised a system of locomotive feedwater heating which makes use of a heater of the open type which is manufactured and marketed by the Worthington Pump and Machinery Corporation. The system follows marine practice in heaters of this type, and the pump and heater have been combined into a single unit which can be conveniently attached to the side of the locomotive

boiler as is the practice with air-brake compressors. Fig. 1 shows a unit with a capacity of 60,000 lb. of feedwater per hour in service on a Mikado locomotive. Fig. 2 is a sectional view of the heater and pump. In these illustrations the heater is shown at the left, the feed pump at the right.

The heater is a simple cast-iron box, the upper part of which is supplied with exhaust steam taken from the locomotive through holes cut in the back of the cylinder saddle and a pipe which has in it a stop check valve and an oil separator, the latter having a small hole in it so that there is a continuous drip for the oil.

The pump is of the vertical type attached to the side of the heater by the various pipe connections. The steam cylinder of the pump is at the top, and it has two water cylinders clearly shown in the illustrations, both operated from the same piston rod. The water cylinder in the middle of the pump takes cold water from the tender and delivers it through a port in the side of the heater to a spray valve in the extreme top of the heater where it is sprayed into the exhaust steam that fills the top of the heater. This condenses as much of the exhaust steam as the water needs to heat it, and the mixture, dropping to the bottom of the heater is taken by the other pump cylinder and delivered to the boiler through the usual check valve. The pump cylinder which takes the cold water from the tender and delivers it to the heater is really a measuring device which feeds into the heat approximately the same amount of water that the lower pump cylinder takes out of the heater, but the varying amounts of exhaust steam condensed in heating the feedwater cause a tendency for a slight excess of water to accumulate so that in time the heater would become flooded. This is prevented by returning this excess water under the control of a bucket in the heater to the pump cylinder in the middle of the pump through one of its pump-suction valves serving this water alone.

The pump is driven by saturated steam taken from the locomotive boiler through a 1-in. steam pipe and controlled by a throttle valve in the cab within convenient reach of the engineer. The exhaust steam from the pump is led into the back of the stop check valve where it mixes with the exhaust steam from the locomotive, and passes with it through the oil separator to the heater. These pipe connections as well as the cold-water pipe from the tender passing back of the air-brake compressor and the feed line from the lower pump cylinder to the boiler are shown in Fig. 1.

The adoption of the open heater for the locomotive may seem a radical step, but from this description it will be evident that no new elements are used. The heater itself is of a general type that has been in use in marine service for at least twenty years. The open heater with the oil separator to remove the oil from the exhaust steam before it enters the heater because of its merits has been almost universally adopted for stationary plants. One of these heater and pump units was thoroughy tested out on the locomotive test plant of the Pennsylvania Railroad at Altoona, Pa., in 1917, and has been in operation on road service since October 1918. Three more units have been in operation for approximately a year on pooled locomotives and have given no trouble other than the usual pump maintenance. Nothing has developed indicating that the open heater as a type is not well adapted to the locomotive and the coal and water savings have been so marked as to be evident to the crew.

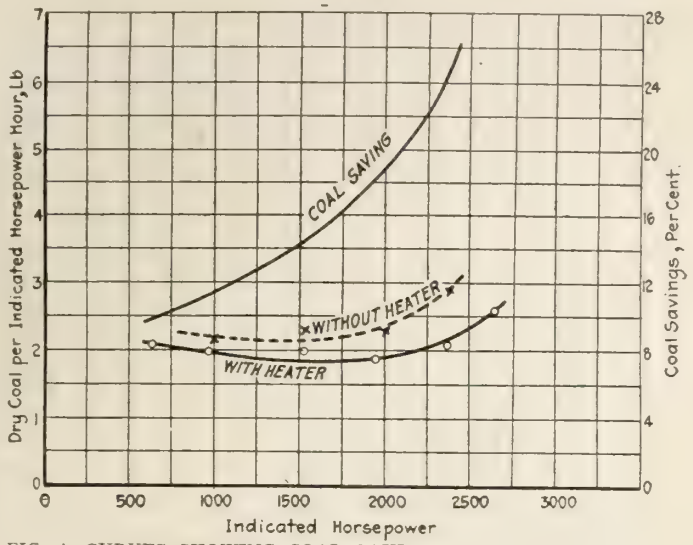


FIG. 4—CURVES SHOWING COAL SAVING BASED ON INDICATED HORSEPOWER.

The pump is much easier to operate than an injector as it requires only a slight turn of the 1-in. throttle valve to either start it or to make it run faster or slower as the boiler may need more or less water. It does not require priming and can be operated continuously at low capacities where the injector must be stopped and started periodically.

The feed pump should not be used, as is often done with the injector, to fill the boiler on the down grade and then be shut off as long as possible on the up grade; first, because there is not as much inducement or necessity for operating it in this way, and secondly, because the prime purpose of the heater is to recover heat and it can only do so when the locomotive is pulling and exhaust steam is available for the heating. If the injector is operated continuously and maintains a constant water level in the boiler each pound of steam generated will require 1276 B. t.u. from the fire with 200 lb. steam pressure, 150 deg. superheat, and 40 deg. water in the tender. If the injector is shut off each pound of steam will require somewhat more than 925 B.t u.

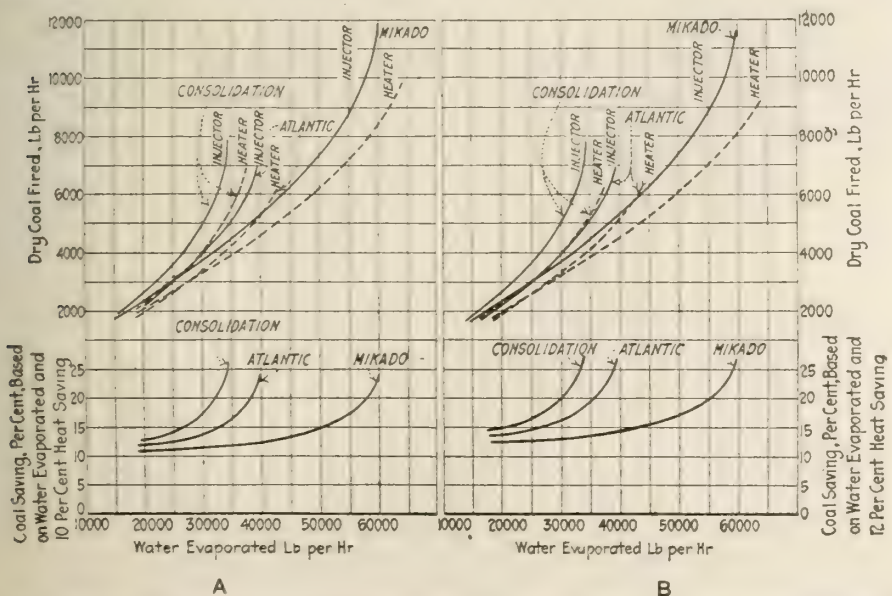

Dry Coal Fired, Lb per Hr
CONSOLIDATION
ATLANTIC
MIKADO
INJECTOR
HEATER
Coal Saving, Per Cent, Based on Water Evaporated and 10 Per Cent Heat Saving
Coal Saving, Per Cent, Based on Water Evaporated and 12 Per Cent Heat Saving
Water Evaporated Lb per Hr
A
B

FIG. 3—CURVES SHOWIUG THEORETICAL COAL SAVING BASED ON WATER EVAPORATED.

so that the amount of steam from the same fire will be increased less than 38 per cent. It will later be shown that under the same conditions the feedwater heater would increase the amount of steam about 13.6 per cent. The feedwater heater will, therefore, materially increase the amount of steam on the up grade, although not to the extent possible in the case of the injector and should be depended upon to feed the boiler entirely on the up grade with the consequent greater amount of heat recovered from the exhaust and more nearly constant water level in the boiler.

Advantages of Locomotive Feedwater Heating

It is not possible to make an exact general statement of the advantages to be obtained from locomotive feedwater heating, because much depends on the particular locomotive to which the heater is to be attached, the capacity at which it is worked, the temperature of the water in the tender, and the basis on which the advantages obtained are stated.

We are able to base our notions as to the advantages of feedwater heating on the results obtained in stationary practice where the coal saving is very properly considered as equivalent to the reduction in the amount of heat necessary to evaporate the water because of the higher temperature at which the water is delivered to the boiler. In the case of the locomotive, however, with its very complicated relations of the different operations that are going on, and the very wide range of capacity through which the boiler is operated, there is generally a much greater coal saving than in stationary practice. Three factors enter into the final result. These are as follows:

1. The reduction in the amount of heat required to evaporate the water in the boiler, which might be called the *heat saving due to the feedwater heater.*

2. The reduction in the amount of heat required results in a greater reduction in the amount of coal required because of the better efficiency of the boiler at the lower rate of combustion. These two factors give the *coal saving based on water evaporated.*

3. The exhaust steam taken by the heater from the exhaust ports of the locomotive reduces slightly the back pressure in the locomotive and should show some advantage. All three factors combined will give *the coal saving based on indicated horsepower.*

An analysis of these three factors will show the coal and water saving referred to the steam that is used in the locomotive cylinders, and therefore, the minimum saving since it does not include the saving in generating the steam used by the auxiliaries. It is necessary to make this analysis partly theoretical assuming certain constant operating conditions in order that a fair comparison may be made of the effect of the heater on different locomotives and at different locomotive capacities. It can only apply to the coal burned while running since the heater can have no influence while standing or at terminals. The percentage of coal saving due to the heater, and to a lesser extent the percentage of water saving when based on ton miles, the month, or the year will be less than the percentage while running by an amount determined by the use made of the locomotives.

Heat Saving Due to Feedwater Heater

The first factor, the heat saving, is determined by the amount the feedwater is heated by exhaust steam taken from the locomotive. This factor will evidently be greatest when the tender-water temperature is low and when the exhaust steam pressure in the heater is highest, as this pressure determines the temperature to which the feedwater can be heated. This pressure will be highest when the locomotive is working hard, and when the exhaust steam for the heater is taken from that part of the steam valve chests or cylinder saddles where its pressure is greatest.

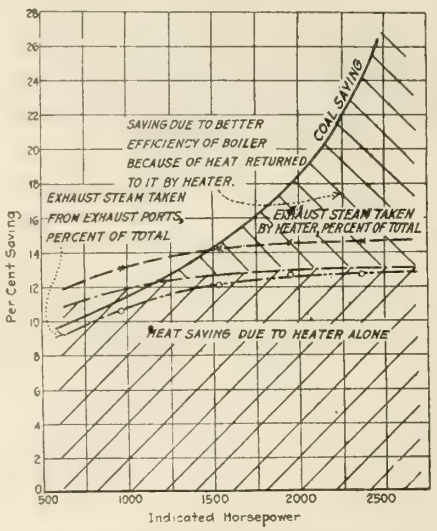


FIG. 5—ANALYSIS OF COAL SAVING BASED ON I.H.P. WITH EXHAUST STEAM LIFT AVAILABLE FOR DRAFT.

The exhaust steam from the feed pump need not be be wasted, since it can be and is used in the feedwater heater, but this use prevents the recovery of the same amount of exhaust steam and heat from the exhaust of the locomotive. The amount of steam used by the feed pump is, therefore, a direct charge against the saving due to feedwater heating as compared to injector operation when considered in the light of recovery of waste heat from the locomotive exhaust, or when estimated by the temperature rise of the feedwater in the heater.

Test plant results and actual daily operation on the road with superheated steam locomotives show that the feedwater heater described can be depended on to effect a reduction of at least 10 per cent. in the summer time and 12 per cent. in the winter time in the amount of heat required to evaporate the water and superheat the steam. This heat saving will not be constant at these figures but will vary with the capacity at which the locomotive is worked because the steam pressure in the heater determines the temperature to which the feedwater can be heated. These figures can, however, be conservatively accepted as representing average working conditions at which the greater part of the coal is burned.

The tabulation given in Table 1 is based on heating the feedwater to 215 deg. This is quite conservative as it has been found easily possible to obtain this temperature with this heater even with tender-water temperatures of 40 deg. and on locomotives worked at less than two-thirds of their maximum capacity. The tabulation shows that greater heat saving is possible with saturated than with superheated steam locomotives; therefore the percentage of coal saving will be greater with saturated than with superheated steam locomotives. Table 2 gives the exhaust steam required for the heating. The percentage of water saved is shown by table 3.

The allowances which have been made for the steam used by the feed pump are based on carefully conducted tests of the feed pump and heater which show that this feed pump when running with saturated and fairly wet steam required for its operation 2 per cent. or less of the weight of steam generated by the boiler. The pump, therefore, uses 2 per cent. or less of the heat required from the fire by the saturated steam locomotive, but in the case of superheated steam locomotive the feed pump will re-

Table 1—Heat Saving Due to Feedwater Heater.

Assumed steam pressure in branch pipe, lb. per sq. in.	200	200	200	200
Assumed superheat, deg. fahr.	None	None	150	150
Assumed temperature water in tender, deg. fahr.	40	70	40	70
Heat content per pound of steam, B.t.u.	1199.1	1199.1	1284.6	1284.6
Heat content per pound of water, B.t.u.:—				
at 40 deg.	8.0	...	8.0	...
at 70 deg.	...	38.0	...	38.0
Heat required to generate one pound of steam, B.t.u.	1191.1	1161.1	1276.6	1246.6
Heat saving in B.t.u. when water is heated from:—				
40 to 215 deg.	175.0	...	175.0	...
70 to 215 deg.	...	145.0	...	145.0
Heat saving, per cent.	14.7	12.5	13.7	11.6
Total heat required by locomotive with feed pump as compared to injector operation, per cent.	102	102	101.75	101.75
Heat saving in locomotive with heater as compared to injector operation, per cent.	15.0	12.75	13.94	11.80
Heat required, per cent.	87.0	89.25	87.81	89.95
Heat saving as compared to injector operation	13.0	10.75	12.2	10.05

quire but about 1.75 per cent. of the heat from the fire of the locomotive because of the greater heat required to generate the superheated steam. The tabulation is based on steam leaving the branch pipe at 200 lb. pressure with 150 deg. superheat in the superheated steam locomotive and gives value of the heat saving, water saving, and percentage of exhaust steam required by the heater for tender-water temperatures of 40 and 70 deg. respectively. The term "heat content" is used to express the amount of heat in the water or steam above that in water at 32 deg. fahr. temperature.

From the tabulation it will also be noted that in the case of the feedwater heater for the locomotive, because of its comparison to injector operation, it is not possible to apply the usual short rule customary in stationary practice stating that a certain number of degrees of heating of the feedwater results in 1 per cent. heat saving, but rather that it is more exact to state, assuming the conditions of the table, that in the saturated steam locomotive, after the first 23.8 or 23.2 deg. heating, each 11.9 or 11.6 deg. of heating represents 1 per cent. heat saving, and that in the superheated steam locomotive after the first 22.3 or 21.8 deg. of heating each 12.8 or 12.5 deg. of heating represents 1 per cent. heat saving, the first figures in each case applying with 40 deg. and the second figures with 70 deg. water temperature.

European practice, as far as the author is informed, involves the use of tubular heaters differing only in details of their construction and discharging to the track the water condensed from the exhaust steam in the heater, thus losing both this water and its heat, necessarily with some additional steam that must be blown through the heater to prevent it becoming air-bound. These locomotives require 2 per cent. more water than when operated with the injector because of the steam used by the feed pump and discharge to the track from 15 to 18 per cent. of this with from 2.6 to 1.8 per cent. of the heat of the saturated and 2.4 to 1.6 per cent. of the heat of the superheated steam locomotive in the water alone for 40 and 70 deg. water respectively. There are a few surface heaters in operation on locomotives in this country in which this water is saved by pumping it back to the tender through filters to remove the oil, but in doing so approximately 80 per cent. of its heat is lost by radiation from the tender. This loss of heat from the locomotive with the surface heater does not count directly against the coal saving since it is supplied by the exhaust steam, but it does count indirectly since it decreases the amount of exhaust steam left available for the draft. The open heater is more economical in the use of exhaust steam and leaves more available for the draft with the possibility of lower back pressure and saving because of this.

The locomotive with the open heater or the surface heater saving the water condensed from the exhaust steam requires the extra 2 per cent. steam to operate the feed pump, but from 15 to 18 per cent. of this 102 per cent. is recovered, so that the net water saving is from 13.3 to 16.4 per cent. respectively for the assumed summer and winter conditions as compared to injector operation.

Coal Saving Based on Water Evaporated

To combine these results with the second factor in order to obtain the coal saving based on water evaporated it is necessary to consider particular locomotives since the second factor involves the change in the efficiency of the boiler with varying boiler capacity. For this purpose the curves of Fig. 3 have been prepared. The curves on the left marked A are on the basis of 10 per cent. heat saving; those on the right marked B on the basis of 12 per cent. heat saving. The upper solid curves marked "Injector" are test plant results of a Consolidation, Atlantic, and Mikado type locomotive respectively, and show the total amount of water evaporated per hour against dry coal fired. The dotted curves marked "Heater" for each of these three locomotives show the amount of water that would have been evaporated by the same amount of coal with a feedwater heater reducing by 10 per cent. respectively the amount of heat required to evaporate the water and superheat the steam. The vertical distances between the solid and dotted curves represent the amount of coal saved and these quantities are shown in the lower set of curves. This lower set of curves, therefore, shows the coal saving based on water evaporated due to the feedwater heater that follows a reduction of 10 per cent. and 12 per cent. respectively in the amount of heat necessary to evaporate the water and superheat the steam. These curves show that the feedwater heater attached to a locomotive will effect a coal saving beginning at low capacities practically identical with the heat saving, or the coal saving which we have been accustomed to in stationary practice, but which increases at first gradually and then more rapidly as the capacity of the locomotive is increased, reaching values twice or more than twice these figures as the maximum capacity of the locomotive is approached.

It would be difficult to credit this result were it not warranted theoretically by the second factor mentioned above, and had it not been confirmed in test plant results with a wide margin to spare. A study of the upper curves in connection with the lower curves of both figures will show that the very great coal saving possible is accompanied by an increase in steaming capacity due to the feedwater heater and that it should be possible to work the locomotive with the heater at greater steaming capacities than are possible with the injector but how much greater would depend largely on the particular locomotive.

Referring to the lower set of curves of Fig. 3 and assuming that the Consolidation locomotive would be operated normally at a steaming rate of say 25,000 lb. per hr., it is noted that the 10 and 12 per cent. heat savings assumed as summer and winter conditions would result in 14 and 16.6 per cent. coal savings respectively. Assuming that the Atlantic type locomotive would also normally be operated at a steaming rate of 25,000 lb. per hr., the coal saving would be 12.8 and 14.5 per cent. respectively. Assuming that the Mikado locomotive is hand fired and operated at a steaming rate of 37,500 lb. per hr., the coal saving would be 12 and 14.2 per cent. respectively.

Table 2—Exhaust Steam Required For Heating

Assumed tender water temperature, deg. fahr.	40	70
B.t.u. required to heat one pound of feedwater to 215 deg.:		
from 40 deg.	175	....
from 70 deg.	....	145
Heat content of exhaust steam assumed at 7 lb. pressure. B.t.u. per lb.	1157	1157
Heat content of water at 215 deg. B.t.u. per lb.	183	183
Heat given up by exhaust steam in condensing from 7 lb. pressure to water at 215 deg. B.t.u. per lb.	974	974
Exhaust steam required to heat one pound of cold feedwater, per cent.	18	15
Exhaust steam to heater from feed pump, per cent.	2	2
Exhaust steam from exhaust ports of locomotive required by surface heater, per cent.	16	13
by open heater, per cent.	13.8	11.5

On the other hand, it is altogether possible that advantage should be taken of the feedwater heater either in increased speed or increased hauling capacity and the same amount of coal burned with it as would have been burned if the locomotive had operated with the injector. In this case, the summertime 10 per cent. heat saving would result in a

$$\frac{100}{100 - 10}$$

per cent. steaming capacity or 11.1 per cent. increase; and the 12 per cent. heat saving would result in a

$$\frac{100}{100 - 12}$$

per cent. steaming capacity or an increase of 13.6 per cent. But as compared to injection operation at this increased steaming capacity the coal saving in the Consolidation locomotive would be 15.5 and 19 per cent., in the Atlantic locomotive 13.3 and 15.5 per cent., and in the Mikado locomotive 13 and 15.3 per cent. respectively.

The feedwater heater does not appear to as great advantage in the Mikado locomotive as in the other type locomotives because it is not as fully loaded.

If the Mikado locomotive was operated at a steaming rate of say 50,000 lb. per hr., the assumed 10 and 12 per cent. saving would have resulted in a 15 and 17.3 per cent. coal-saving respectively, and if advantage had been taken of the feedwater heater for the increased capacity burning the same amount of coal as with the injector the coal saving would have been 18 and 21.2 per cent. respectively.

Coal Saving Based on Indicated horsepower

Any modification which the third factor makes in the combination of the first two factors as shown in Fig 3, leading up to the coal saving per indicated horsepower, must be but slight and depend on the particular locomotive. Saturated steam locomotives should show a further gain of a few per cent. from reduced back pressure. Test plant records show some reduction in this back pressure in superheated steam locomotives accompanied by a reduction in superheat and indicate that, at least until further tests are made, this factor should not be considered for superheated steam locomotives.

The curves of Fig. 4 are test plant results of a Mikado locomotive, comparing its operation with the injector and with the feedwater heater described in this paper. Table 4 shows the heat recovered by the feedwater heater and Table 5 the coal saving and increase in efficiency. They show a coal saving curve of the same general character, but slightly higher than the curve for the Mikado locomotive of Fig. 3, based on water evaporated, although the tests were made under practically identical operating conditions as to temperatures and pressures.

The coal-saving curve of Fig. 4 has been reproduced in Fig. 5, and a curve added showing the reduction in the amount of heat required to evaporate the water and superheat the steam, because of the heater. The cross-hatched area above this curve shows the additional saving presumably all due to the better efficiency of the boiler with the reduced amount of heat required from the fire because of the heat recovered by the heater.

Exhaust Steam Available for the Draft

The question has been raised as to whether the exhaust steam taken from the locomotive by the feedwater heater would cause trouble with the draft. This question could be analyzed from the partly theoretical curves of Fig 3, but as actual operating conditions are of more interest, curves have been added to Fig. 5 showing the total exhaust steam taken by the heater and the exhaust steam taken from the exhaust ports of the locomotive. The distance between these two curves represents the exhaust steam furnished by the feed pump to the heater. It is noted that the curve of exhaust steam taken from the exhaust port is below the curve of coal saving. The feedwater heater, therefore, reduced the amount of coal burned at a greater rate than it reduced the amount of exhaust steam, so that there was surplus of exhaust steam left available for the draft and no necessity for reducing the size of the blast nozzle and consequent possibility of reduced back pressure in the locomotive cylinders because of this heater. For instance, at 2,000 i.h.p., the reduction in the amount of coal burned was 18 per cent., and in the amount of exhaust steam, 12½ per cent. As compared to injector operation, 82 parts of coal had to be burned and 87½ parts of exhaust steam were left available for the draft to burn it.

Table 3—Water Saving Due to Feedwater Heater

Steam for locomotive cylinders, per cent.	100	100
Steam required for feed pump, per cent.	2	2
Water required by locomotive with surface heater discharging water condensed from exhaust steam to track, as compared to injector operation, per cent.	102	102
Exhaust steam condensed in heating feed water, per cent.:		
0.18×102	18.4	...
0.15×102	...	15.3
Water required by locomotive with open heater or surface heater saving condensation from exhaust steam compared to injector operation, per cent.	83.6	86.7
Water saving, per cent.	16.4	13.3

Table 4—Heat Recovered by the Feedwater Heater.

Test No.	1	2	3	4
Steam to engine, lb. per min.	314.5	492.8	599.1	757.3
Steam to feed pump, lb. per min.	7.4	10.5	12.5	14.6
Steam to safety valve, lb. per min.	0.8	0.7	2.1	5.5
Exhaust steam condensed, lb. per min.	42.3	71.4	90.0	113.7
Heat in steam, B.t.u. per min. to engines	402,749	639,063	780,867	996,531
to feed pump	8,876	12,594	14,994	17,393
to safety valve	960	840	2,519	6,597
Total heat in steam	412,585	652,497	798,380	1,020,521
Heat recovered from exhaust, B.t.u. per min.	50,725	85,694	108,063	136,736
Per cent. of total heat	12.3	13.1	13.5	13.4

Table 5—Coal Saving and Increase in Effciency With Feedwater Heater

Test No.	1 and 5	2 and 6	3 and 7	4 and 8
Speed in m.p.h.	14.6	14.6	22.0	22.0
Indicated horsepower:				
Without heater	990	1549	2001	2388
With heater	965	1534	1949	2373
Coal per indicated horsepower hour, lb.:				
Without heater	2.2	2.3	2.3	2.9
With heater	2.0	2.0	1.9	2.2
Coal saving by feed heating, per cent.	9.1	13.1	17.4	24.7
Drawbar horsepower:				
Without heater	824	1289	1690	2019
With heater	783	1293	1679	2055
Thermal efficiency of locomotive, per cent.:				
Without heater	7.0	6.7	6.7	5.4
With heater	7.6	8.0	8.6	7.8
Increase in efficiency with heater, per cent.	8.5	19.4	28.3	44.4

Conclusions

The feedwater heater on the locomotive may be used to reduce the coal and water consumption working the locomotive at the same capacity as with the injector or to increase the capacity of the locomotive, or partly for both, as occasion demands. It will save coal and water all the time, and permit of increased capacity when needed.

The feedwater heater might be considered as alternate to large size of locomotive boiler and grate as a means to coal economy, if for any reason both are not considered advisable or possible for still further economy. This feature is well illustrated in Fig. 3, where it is noted that the Consolidation locomotive with an open heater gives more steam per pound of coal burned than the Mikado locomtive without a heater up to 2800 lb. of dry coal fired per hr., with the 10 per cent. heat saving, and up to 3000 lb. per hr. with the 12 per cent. heat saving. Test plant records show the Consolidation with heater burns less coal per indicated horsepower than the Mikado without heater up to a still greater rate of coal fired. The smaller amount of coal burned by the Consolidation locomotive at terminals and its lower first cost and maintenance cost favor it still further in the comparison.

Viewed from the standpoint of coal and water saving, the adoption of the heater becomes a question of interest on first cost, depreciation and maintenance cost against these savings. Viewed from the standpoint of increased capacity, the question becomes one as to whether the feedwater heater does not offer increased capacity at the lowest first cost, especially if, as in the case of the comparison of the Consolidation locomotive with and the Mikado locomotive without a heater, the adoption of the heater permits of the use of a simpler and less costly type of locomotive.

The feedwater heater offers a solution of the pressing problem of these times, when so many fairly old and small locomotives have outgrown their usefulness because they are not large enough for present-day demands. The feedwater heater will not only increase the capacity of these locomotives, or what might be called their economical operating capacity, at a comparatively low cost and with little change in them, but it will also show a larger percentage of coal saving because of their full loading than would be obtained with present-day larger locomotives.

The feedwater heater offers the peculiar advantage of being of most assistance to the locomotive just at the time when the locomotive needs assistance. It offers its greatest saving in fuel or increase in capacity in the winter time, and these advantages are not ef-

fected by reduced steam pressure or superheat, but continue in spite of them and at a proportionately greater rate.

The study of the subject of the feedwater heater for the locomotive that has been reviewed in this paper has resulted in the adoption of the open-feedwater heater as a type. It has been developed into a unit with the pump, so that it can be attached to the locomotive at minimum expense. These units have been thoroughly tested both on the test plant and on the road, and every confidence is felt in their ability to meet the severe requirements of locomotive service, and to effect the maximum possible saving of fuel and water with a minimum amount of attention from the crew.

STANDARDIZATION OF STRUCTURAL SHAPES

On the entrance of the United States into the war with the Central Powers there came a demand for immediate increase in ship construction which, in turn, meant increased production by the steel mills. To increase production to the minimum and to simplify order practice, a conference of steel makers was held in Washington on July 2, 1917, at which was adopted American standard practice for structural steel for ships.

The result of this action proved distinctly beneficial both to the mills and the shipyards, but was not followed immediately by a standardization of and a reduction in the number of structural shapes used at the yards, and in consequence the Emergency Fleet Corporation undertook an investigation to ascertain definitely the number of structural shapes used in shipbuilding and the possibility of their standardization and reduction in number. As an outcome of these investigations carried on by Mr. Fred T. Llewellyn in the Division of Steel Ship Construction under Daniel H. Cox, Manager, it became possible to determine what were the sections in most general use and at the same time were brought out clearly the divergencies in the sections rolled by different mills

At a conference of steel makers held in Philadelphia on November, 19, 1918, inasmuch as the British standard sections of ship channels and shipbuilding bulb angles appeared to be better adapted to economical manufacture than the American standard sections and inasmuch further as the new rolls which had been turned in recent years to produce sections conformed in general to British standards, it was decided that therefore American standard sections should be discontinued and that rolls not then to British standards be redressed at as early a date as possible to roll such sections as closely as possible to British standards and this particularly in view of the further fact that the adoption of British standard sections would enable American mills to compete on an even basis for ship steel wherever utilized in shipyards, either at home or overseas.

The British standard sections thus adopted as American standards were those adopted by the British Engineering Standards Association as published in 1903, and it was not known that this Association had undertaken a revision of the British standard sections in 1913, work on which, however, had been suspended by reason of the war activities. When, however, through the trade press, information as to what had been done in the United States came to the attention of the British Engineering Standards Association, that Association advised American steel makers as to the situation and later through their secretary, Mr. LeMaistre, expressed their desire to have the American structural trade co-operate with the British Engineering Standards Association in the formulation of common Anglo-American standards for structural shapes.

At the instance of the Association of American Steel Manufacturers, a Sectional Committee on Steel Shapes was organized under the auspices of the American Engineering Standards Committee. This Sectional Committee is composed as follows:

American Bureau of Shipping—Captain C. A. McAllister; David Arnott; John Martin.

American Society of Civil Engineers—J. H. Edwards; J. B. French; H. G. Balcolm.

Association of American Steel Manufacturers—R. B. Woodworth, (Chairman); G. H. Blakely; Geo. E. Thackeray.

Railway Car Manufacturers' Association—A. E. Ostrander.

Society of Naval Architects and Marine Engineers—Fred T. Llewellyn; E. H. Rigg; J. W. Stewart.

United States Navy — Commander C. M. Simmers; Lieut. Com. H. D. Rouzer.

The Sectional Committee gave very careful consideration to the entire routine of structural practice in the United States not only as it affects the profiles of structural shapes themselves, but also as regards methods of order practice, calculation and publication of weights, areas and properties, etc., with the idea to insure as far as possible a complete accord between makers and users wherever the sections rolled in English - speaking lands were used. At its meeting held on April 27, 1920, it formulated its recommendations for submission to its sponsor organizations, to the American Engineering Standards Committee and to the British Engineering Standards Association as a basis for common Anglo-American standards, and its conclusions are now to go before these organizations for further discussion and endorsement. The essential features of these recommendations are:—

1. The adoption of the decimal system for the expression of dimensions, thicknesses and other elements of order practice.

2. The adoption as an Anglo-American standard of the standard order practice adopted by the Association of American Steel Manufacturers on February 20, 1920, under which structural shapes are to be ordered by weights per foot and not by thickness.

3. The adoption as an Anglo-American standard of American standard practice as it relates to ranges of thicknesses, methods of computation and methods of publication.

4. The adoption of definite ranges in thicknesses of angles and other structural shapes, under which are established two zones of variations between minimum and maximum thicknesses. Under .60-in. thick variations are fixed at four one-hundredths inch (0.04-in.) and above .60-in. thick at eight one hundredths inch (0.08-in.)

5. Included in the list of angles is an equal angle (9x9) and four unequal angles (8x4, 9x4, 9x6 and 10x4) which are not now rolled in United States, but are subject to the considerations which weigh with manufacturers when new rolls are contemplated.

6. The adoption of a new line of bulb angle sections as proposed by the British Engineering Standards Association that are recommended on account of their greater efficiency as compared with present British and American standards.

7. The adoption of a single line of channel sections with a 5 deg. flange taper to displace the present two American lines, the structural line with its flange taper 9 deg. 27′ 42″ and the shipbuilding line with its flange taper of 2 deg. This line of channel sections is not quite in accord with that proposed by the British Engineering Standards Association, but is believed to be more suitable to the requirements of the American trade and better proportioned.

8. The adoption of a new line of beam sections to take the place of the present American standards adopted in 1896. These sections have wider flanges than present American standards and do not agree very closely with the British proposals, but are believed by the Sectional Committee to be more nearly in accord with the recent developments in the fabrication of buildings and bridges.

A recent communication to the French Academy of Sciences, states that coal has been discovered in the region of Port Gueydon, French North Africa. This coal appears to belong to very extensive beds lying in the region mentioned. Analysis taken have revealed the following composition:—"Moisture, 1.05 to 1.15 per cent.; ash, 37.15 to 53.65 per cent.; volatile matter, 8.05 to 12.27 per cent.; fixed carbon and sulphur, 37.25 to 49.45 per cent; the calorific value varies from 3960 to 5390 calories.

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The Council of Action

THE creating of what is known as a Council of Action by the leading trades unions in Great Britain, with the avowed object of dictating to the Government its policy on certain questions of national importance, creates, as Mr. Lloyd George plainly states, "the most formidable challenge ever given to democracy." There can be no doubt that the people of Great Britain generally are war weary, and not labor alone. The greatest beneficiaries of the war were the trades unionists, and some of the capitalists, though not by any means all. It is the great middle classes who suffered the most and got nothing at all out of it who would probably be the most unwilling to see their country embarked on another period of war. Their voice, however, is not heard above the clamor made by the representatives of organized labor, which, after all, is by no means a majority of the community, but, on the other hand, a relatively small portion. Organized labor in Great Britain has, since the war, been frankly out to get everything it could possibly extort, and has not been afraid, in this endeavor, to attempt the complete paralysis of the country. The great transportation strike should have taught their representatives that when they go in opposition to the general public they are comparatively powerless, and it is quite possible that in making their threats of a general strike in the event of Britain taking action in Poland, they did so with their tongues in their cheeks. As a matter of fact, the British Prime Minister says that the aims of the Government and the aims of the Council of Action are practically the same, but he plainly and positively states that were they not, "dictation would be resisted by all means in the power of the Government." Trades unions can serve an excellent purpose, and have been instrumental in making life a more pleasant thing for the trades unionist. When they start to assume the role of the Government it is time to call a halt. While every right-minded person wishes to see labor, both organized and unorganized, get all the good out of life that it is possible to obtain, no sane person wishes to see any minority of the people holding a club over the rest. Lloyd George is to be congratulated on his uncompromising stand against such coercion.

The Engineer's Opportunity

THE organization of the Federated Engineering Societies at their recent conference at Washington, D.C., is certainly a step in the right direction.

About 75 branches of the engineering profession were represented, these including Civil, Mechanical, Mining, Electrical, Sanitary, Heating, Marine, Agricultural, Radio, Refrigerating, Fire Protection, Industrial, Automotive, Military Engineers, Architects and Geologists, etc.

The need of such a body has been felt for years, but the problem was to successfully affiliate the various interests. The action taken at Washington has removed the only remaining nigger in the woodpile.

The object of this newly formed body is both ambitious and essential. They desire to raise the standing of engineers generally, and to teach the public how much they really depend upon the engineering profession. Any society, club or organization, the chief object of which is the advancement of the knowledge and practice of engineering and the application of applied sciences, and which is not organized for commercial purposes, is eligible for membership.

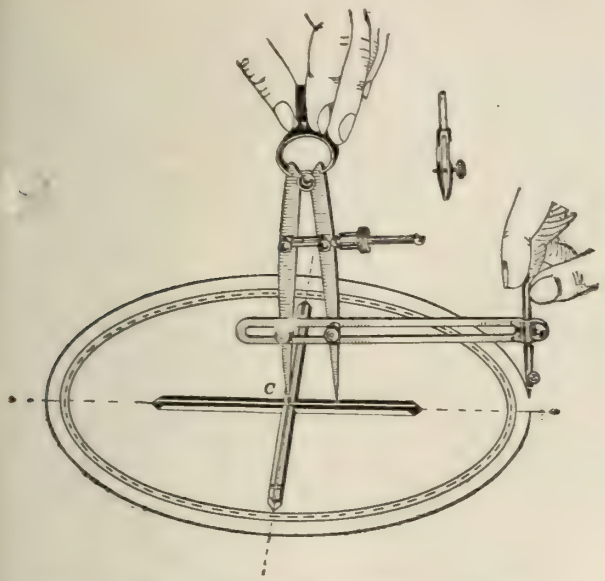
The success of this society, as we see it from our side of the line, depends entirely upon the engineers themselves. With proper support this body should grow to be a powerful influence and will form the official mouthpiece, so to speak, for engineers all over the country.

To our mind the forming of this society should be greeted with great enthusiasm by engineers in general and they should rally to its support. An opportunity such as this affords is not to be treated lightly. We will watch with interest the development of the organization, and once more emphasize the necessity of every engineer becoming a live member and actual booster.

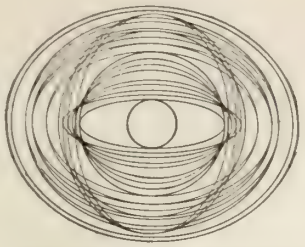
—Thomas in the Detroit "News."
"City folks get themselves into the durnedest messes."

REID ELLIPSOGRAPH

Daniel C. Reid, 2717 N. Croskey Street, Philadelphia, Pa.. has placed on the market what is known as the Reid Ellipsograph. This instrument is claimed to draw all kinds of ellipses or ovals, from 1½ in. up to 12 in. major axis, and describes a perfect ellipse in one operation.



THIS VIEW SHOWS THE INSTRUMENT IN USE.



THE WORK ACCOMPLISHED

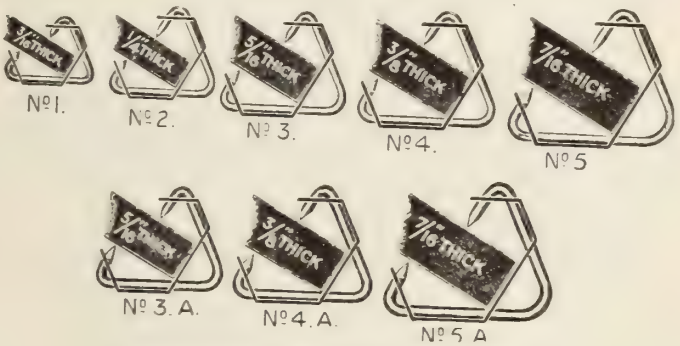
The instrument is provided with pen and pen parts, and can also be used for drawing circles up to 12 in. diam. It can also be used as an ordinary divider. This announcement will no doubt appeal to draftsmen, designers, illustrators, architects, etc. To illustrate its construction we show the illustrations herewith.

UNIVERSAL BELT FASTENERS

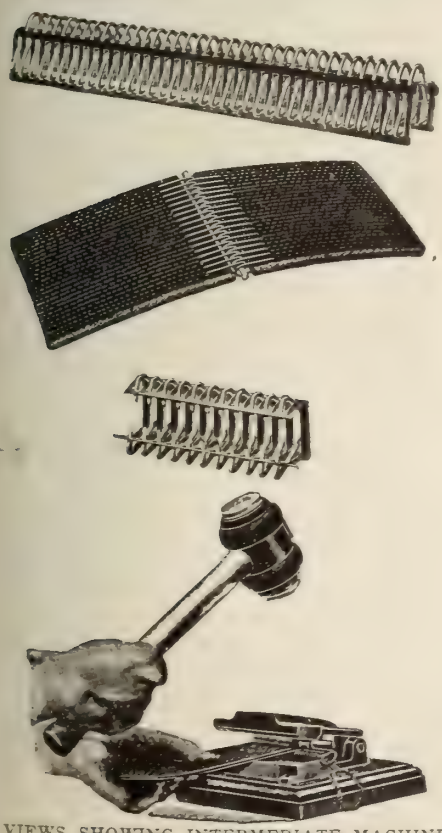
An improved type of belt fastener, known as the "Universal," has been placed on the Canadian market by the Climax Company, of 244 Lemoine Street, Montreal. These fasteners are the result of careful study and exhaustive experiment on the part of the makers, and are universal in character. They are equally efficient in rubber, balata, leather or cotton belting, and are made in six-inch lengths, of sizes varying to take belts from 3-16 to 7-16 inch in thickness. The individual hooks are held in position by a metal frame which retains the hooks in the same relative position all the time the hooks are being forced into the belt. When the hooks are flush with the belt the frame slips off freely. The fasteners are made in two gauges of wire, the larger sizes being adapted to meet the requirements of the user who has extra heavy belts running over small pulleys.

On the intermediate fasteners the wire can be laced into the belt with a simple hammering tool, economically and efficiently. For the larger sizes, a special lacing machine is preferable. On the smallest sizes, the lacing can be performed by using a hammer and a wooden block, the metal frame assuring perfect alignment during the operation. The great advantage of the metal frame is that it prevents the hooks from twisting to one side or the other while being forced into the belt. The fasteners are made with a series of hooks having long and short legs, the short legs entering the belt on the pulley side, this method minimizing the metal contact on the pulley and reducing the possible slip. The hooks do not meet in the belt, but are individually staggered, thus increasing the effective pull.

The fasteners can be cut to any desired length without fear of wasted ends, as the metal frame keeps the pieces intact. A pair of narrow scissors are provided for cutting the metal frame.



VIEW SHOWING THE VARIOUS SIZE HOOKS.



VIEWS SHOWING INTERMEDIATE MACHINE AND OTHER DETAILS.

THE HEAVIER TYPE MACHINE.

We have received Bulletin B-410 of the Yarnall-Waring Co., describing the Yarway seatless and Yarway double tightening blow-off valves. There is an interesting diagram showing the cost of leaky blow-off valves. This shows by means of a curve loss in water and coal in dollars per month and per year, and water loss in thousands of gallons per month. These valves are constructed to conform to the A. S. M. E. standards. The double tightening valve was originally made to use in conjunction with the Yarway seatless valve in places where the boiler laws require the use of two valves. Anybody interested in blow-off valves can obtain a copy of the bulletin by requesting one from the makers, Yarnall & Waring Co., Chestnut Hill, Philadelphia.

Want To Get Heat.—A strong committee has been appointed by the Board of Directors of the Chamber of Commerce of Chatham, to meet representatives of the Chatham Heating Co. The object of the committee is to try and prevent a repetition of last year's experience, when business suffered to a considerable extent due to a lack of heat, which it is claimed the company failed to supply.

TRADE GOSSIP

The Canadian Pacific Railway Company announce the apopintment of Mr. F. S. Rosseter to be acting Superintendent, Chapleau Division, with headquarters at Chapleau, vice Mr. W. R. Boucher, who has received a month's leave of absence.

Want To Export Coal. — The chairman of the Dominion Railway Commission is receiving many applications for permission to export coal. There has been an order against the export of any coal from August 1st, and the applicants claim that they had the contracts made and vessels chartered to carry the coal before the order came out. They, therefore, claim that they should be allowed to export those orders.

Car Shops for Toronto.—It is understood that representatives of car-building firms have been looking over the ground with a view to establishing a street car building shop in Toronto. This is irrespective of the continuation of the Toronto Street Railway's shops for car manufacturing. There is a probability also that the plant of the Dominion Shipbuilding Co. may be utilised for this purpose.

Alberta's Coal Export Increased. — The output of the Alberta mines for the six months ending July 31st was 3,043,940 tons, as compared with 2,068,907 tons for the same period last year. There has been more coal marketed during the six months period than in any corresponding period in the history of coal mining in Alberta. The exportations for the six months show a 50 per cent. increase.

Coal Situation Better.—According to Mr. J. D. A. Morrow, vice-president of the National Coal Association in the United States, and who has just returned from a ten days' trip, the situation is better than it was. Due to the increased car supply, a big increase in the coal shipped to New England and the North-West besides other parts of the country had taken place. The production for last week, he estimated, was about 11 000 000 tons, which is still 1,000,000 tons under the normal requirements.

Hydro Business Last Year. — In a statement made by the Hydro Electric Commissioners, the following figures are given. The number of municipalities taking power has increased in ten years from 12 to 115, and the power distributed from 25,000 to 225,000. There are 12 rural systems, 23 companies, and five Government industries. The total assets at the Falls and in the municipalities amount to $40.693,070 and the accumulated reserves $7,654,370 and the surplus $2,177,934.

Mine Sells Entire Output.—The Blue Diamond Coal Mines at Brule, Alta., have contracted their entire output for the next six months, according to J. P. Bickell. Mr. Bickell is a director of the McIntyre Porcupine Mines, Ltd., which has just purchased the coal mining company. The contract is for the west, and the entire capacity is required, even if it exceeds 2,000 tons per day. The output is at present about 600 tons per day, and it will require over a year to bring the output up to 2,000 tons per day.

Starting in Vancouver.—The Britannia Wire Rope Co., is getting in shape to operate at their plant on Granville Island, B.C. The machinery for most of the plant is now on the way from England. C. H. Gill is the British director, and Robert Gibson, managing director.

Conference in Fall.—The second great Industrial Conference will be held in Canada some time in October or November. An appropriation was made by Parliament at last session to cover the expenses of the conferences, and it is expected that the experience gained at the last conference will result in making this one an even more representative gathering of labor, capital and the general public.

New Rates Contract. — The Special Scale Committee of coal operators and miners sitting in District 18, Calgary, have completed their labors. The agreement is between the Western Canada Coal Operators' Association and District 18, of the United Mine Workers of America. The agreement provides for an all-round increase, and is in force till April next, and retroactive from March last.

Baldwin Plant Ready Soon. — The plant at Ashbridge's Bay will be ready for operation in about three weeks' time. it is expected. There will be a staff of between eight and nine hundred men employed at the beginning, and when the plant has worked up to full capacity it will employ 6,000. A large number of the men are coming direct from the works in Wales and incidentally among these are included some who were in Moscow with the general manager of the plant here, Mr. Cound.

Bounty for Iron Industry.—The Hon. William Sloane, Minister of Mines for the Province of British Columbia, speaking about the possibility of an iron smelting industry in the Pacific Coast Province, pointed out that the present bounty offered by the Provincial Government would amount on a 300-ton plan to something like $1,000,000. He stated that Mr. Fleming, of the Canadian Collieries (Dunsmuir), was looking into the situation, as their company thought of entering into the industry. As to the claim that there would be no market for the product, Mr. Sloan thought there would be no difficulty on that score, as the Pacific Coast could be supplied at prices beyond the competition of eastern furnaces. In any case, he thought the Federal Government could be induced to build extensive car shops for the National Railways at one of the western terminals, which would absorb a large percentage of the output of a 300-ton furnace.

Herbert Johnson, of the Armstrong Whitworth Company of Canada, has been appointed general superintendent of the plant at Longueuil. Lawrence Russell, the general manager, will be in charge of the sales.

Have Bought Factory.—The Dominion Cone Company have sold their factory at 14 Morrow Avenue to Tarbox Bros., specialty manufacturers. The building is of two storey brick, with a basement, the total floor space being 12,500 square feet. The frontage is 40 feet The deal was closed through Robins, Ltd.

Brantford City Engineer.—Mr. Frank Adams, city engineer of Chatham, has been appointed city engineer of Brantford, at a salary of $3,600 for the present year, and $4,000 for next year. Mr. Adams is an old Brantford boy, and well acquainted with the locality, and its special problems. He will take up his duties on September 15th next, succeeding the late Major Harry Jones.

ACCIDENT PREVENTION

Accidents and accident prevention in machine building are discussed in Bulletin No. 256 published by the United States Bureau of Labour Statistics. The booklet gives the result of an investigation to ascertain the frequency and severity of accidents in the machine-building industry, and to study and analyse these accidents in such a way as to supply the information necessary for effective safety work, To this end the report seeks, as far as possible, to locate the accident hazards in particular departments and occupations, to discover the reason and causes for the occurrence of accidents, and to point out some of the more successful methods for their prevention. The investigation was limited to certain selected plants representing the more important classes of product, and covered in all 194 plants. Accident rates are analysed for the industry as a whole, by character of products, and by departments. Inability to speak English as related to accidents, safety organization, direct safeguarding methods in machine building, and machine design as a factor of safety, are among the subjects discussed.

OPTICAL INSTRUMENTS

Optical equipment for the inspection of flat surfaces and the comparison of standards, is a line of tools now being placed on the market by the Van Keuren Company of Boston, Mass. By means of these instruments comparisons can be made to one-half a wave length of light, which for daylight is approximately 0.00001 inch. It is claimed that the working flats of the set will register an accuracy of 0.000005 inch and that of the master flat to within 0.00000025 inch. Full instructions are included with the instruments and the equipment is intended for shop use.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-Finished and Finished Materials Entering into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size.	Seamless	Lapweld.
1 -in.	$27 00	$.....
1¼-in.	29 50	.....
1½-in.	31 50	29 50
1¾-in.	31 50	30 00
2 -in.	35 00	29 00
2½-in.	42 00	37 00
3 -in.	50 00	48 00
3¼-in.	.....	48 50
3½-in.	63 00	51 50
4 -in.	85 00	65 50

Above prices advanced 5%

Prices per 100 ft., Montreal and Toronto.

PLATES

Plates, 3/16-in.	$ 7 25	$ 7 25
Plates, ¼-in. up	6 50	6 50

Price List No. 38

WROUGHT PIPES

Standard Buttweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
⅛	$ 6 50	$ 8 50	$.....	$.....
¼	5 13	7 27	5 31	7 44
⅜	5 13	7 26	5 31	7 44
½	6 86	8 42	7 10	8 67
¾	8 45	10 58	9 03	11 16
1	12 50	15 64	13 35	16 49
1¼	16 91	21 16	18 06	22 31
1½	20 21	15 20	21 59	26 68
2	27 20	34 04	29 95	35 89
2½	43 00	53 82	.....	.....
3	53 93	68 09	.....	.....
3½	68 54	85 56	.....	.....
4	81 21	101 37	.....	.....

Standard Lapweld

Per 100 feet

	Steel		Gen. Wrot. Iron	
	Black	Galv.	Black	Galv.
2	$29 79	$36 63	$33 49	$39 96
2½	43 58	54 41	49 43	60 26
3	56 99	71 15	64 64	78 80
3½	70 38	87 40	79 58	96 60
4	83 39	103 55	94 29	114 45
4½	95	1 19	1 20	1 45
5	1 10	1 39	1 40	1 69
6	1 43	1 80	1 81	2 19
7	1 87	2 36	2 34	2 83
8L	1 96	2 48	2 46	2 98
8	2 26	2 85	2 84	3 43
9	2 71	3 42	3 40	4 11
10L	2 51	3 17	3 15	3 81
10	3 23	4 08	4 06	4 90

Terms 2% 30 days, approved credit.

Freight equalized on Chatham, Guelph, Hamilton, London, Montreal, Toronto, and Welland.

Prices — Ontario, Quebec and Maritime Provinces

WROUGHT NIPPLES

4-in. and under, 60%.
4½-in. and larger, 50%.
4-in. and under, running thread, 30%.
Standard couplings, 4-in. and under, 40%
4½-in. and larger, 20%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 15% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings: Class B black, 24½c lb.; class C black, 15¾c lb.; galvanized, class B, 34c lb.; class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING

At warehouse ..... base $7.75

FILES AND RASPS

Globe	50
Vulcan	50
P. H. and Imperial	50
Nicholson	32½
Black Diamond	27½
J. Barton Smith, Eagle	50
McClelland, Globe	50
Delta Files	20
Disston	40
Whitman & Barnes	50
Great Western-American	50
Kearney & Foot, Arcade	50

OILS AND COMPOUNDS

Castor Oil, per lb	..
Royalite, per gal., bulk	24½
Palacine	27½
Machine oil, per gal.	54½
Black oil, per gal.	28
Cylinder Oil, Capital	82
Cylinder Oil, Acme	70
Standard cutting comp., gal	06
Lard Oil, per gal	2 60
Union thread-cutting oil, antisep.	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil, bbls. net	18

BELTING — No. 1 OAK TANNED

Extra heavy, single and double	6½
Standard	6½
Cpt leather lacing, No. 1	2 00
Leather in side	2 40

BOLTS, NUTS AND SCREWS

Carriage bolts, ⅜-in. and less	10%
Carriage bolts, 7/16 and up	Net
Coach and lag screws	15
Stove bolts	55
Wrought washers	25
Machine bolts, 7/16 and over	10
Machine bolts, ⅜-in. and less	20
Mach. screws, flt and rd hd, steel.	27½
Mach. screws, ov. and fil. hd., steel	10
Mach. screws, flt. and rd. hd, brass	Net
Mach. screws, ov. and fil. hd., br.	Net
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hexagon, blank	add 1 75
Nuts, hexagon, tapped	add 2 00
Copper rivets and burrs, list less	15%
Burrs only, list plus	25%
Iron rivets and burrs	40 and 5
Boiler rivets, base ¾-in. and larger	$8 50
Structural rivets, as above	8 40
Wood screws, ov. and rd., bright	75%
Wood screws, flat, bright	77½
Wood screws, flat brass	55
Wood screws ov. and rd., brass	55½

MISCELLANEOUS

Solder, strictly	$ 0 40
Solder, guaranteed	0 39
Babbitt metals	0 18 to 0 70
Soldering coppers, lb	58
Lead wool, per lb	0 14
Putty, 100-lb. drums	6 75
White lead, pure, cwt	17 80
Red dry lead, 100-lb. kegs, cwt.	16 50
Glue, English	0 35
Tarred slater's paper, roll	1 30
Gasoline, per gal., bulk	0 33
Benzine, per gal., bulk	0 32
Pure turp., single bbls., gal	1 50
Linseed oil, raw, single bbls	2 90
Linseed oil, boiled, single bbls	2 92
Plaster paris, per bbl	4 50
Sandpaper, B. & A.	list, plus 43%
Emery cloth	list, plus 37½%
Sal soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Borax, crystal and granular	0 14
Wood alcohol, per gal.	2 00
Whiting, plain, per 100 lbs	2 50

COPPER PRODUCTS

	Mont.	Toronto
Bars, ½ to 2-in.	$42 50	$43 00
Copper wire, list plus 10%		
Plain sheets, 14-oz., 14 x 60-in.	46 00	44 00
Copper sheet, tinned, 14 x 60, 14-oz.	48 00	48 00
Copper sheet, planished, 16-oz. base	46 00	45 00
Braziers', in sheets, 6 x 4 base	45 00	44 00
Copper tubing, seamless	0 43	0 43

RUBBER BELTING

Standard	10%
Best grades	15%

WASTE

XXX Extra	24	Atlas	20
Peerless	22½	X Empire	19½
Grand	22½	Ideal	19
Superior	22½	X Press	17½
X L C R	21		

Colored

Lion	17	Popular	13
Standard	15	Keen	11
No. 1	15		

Wool Packing

Arrow	35	Anvil	22
Axle	28	Anchor	17

Washed Wipers

Select white. 20	Dark colored. 09
Mixed colored 10	

This list subject to trade discount for quantity

ROPE AND PACKINGS

Drilling cables, Manila	0 39
Plumbers' oakum, per lb	0 10¼
Packing, square, braided	0 38
Packing, No. 1 Italian	0 44
Packing, No. 2 Italian	0 32
Pure Manila rope	0 32
British Manila rope	0 26
New Zealand hemp	0 26
Transmission rope, Manila	0 43
Cotton rope, ¼-in. and up	0 80

METALS	Gross Mont.	Toronto
Tin	$65 00	$65 00
Spelter	12 00	12 00
Lead	11 00	11 00
Antimony	14 50	14 00
Aluminum	34 00	35 00

Prices per 100 lbs.

LEAD SHEETS

	Mont.	Toronto
Sheets, 3 lbs. sq. ft.	$10 75	$11 50
Sheets, 3½ lbs. sq. ft.	10 50	11 00
Sheets, 4 to 6 lbs., sq. ft.	10 25	10 50

Cut sheets, ½c lb. extra.
Cut sheets to size, 1c lb. extra.

CONE PULLEY BELT SHIFTERS

Speaking on the above subject before the summer conference of the National Safety Council (Engineering Section), Mr. H. E. Somes, electrical engineer of the Chevrolet Motor Co., made the following statements:

At your last meeting, I volunteered to obtain time studies on mechanical belt shifters for cone pulley belts and on the hand method. After going through a number of large machine shops, I was very much surprised to find that, with the exception of an isolated instance, belt shifter devices for cone pulley belts were not used; and due to that fact, and also the short period of time left to investigate this subject, I have been unable as yet to obtain the time studies. One of our factory managers who has a successful belt shifter installed expressed it as his opinion that a green workman can shift cone pulley belts by means of the belt shifter as rapidly as an experienced workmen can shift them by hand—with the additional advantage that in doing so he is safeguarded from injury. However, in my investigations on this subject, I have been convinced of the fact that mechanical belt shifters can be developed that will shift belts on cone pulleys more rapidly than by means of the hand shifting method—much more safely and efficiently and without serious injury to the belt itself. Possibly such shifters have already been developed.

The problem, however, seems to be where should cone pulley belt shifters be required? Such a shifter has its maximum value when it is installed on a machine where belts are shifted many times per day. If a saving can be realized in the workman's time, due to an improved method of shifting belts and the machine itself has a greater capacity, these advantages will become more apparent as the number of belt changes increases. Usually the advantages become of lesser importance as the number of shiftings decreases.

I would submit, therefore, at this time that mechanical belt shifters for cone pulleys are particularly adapted to shop installations where frequent shiftings of the belts from one step cone to another is necessary. Among such installations we find the tool room, the maintenance or the repair shops, and many other types of manufacturing machine shops which can possibly be classified wherein belt shifting is a necessity.

Considering the modern manufacturing machine shop, such as the automobile manufacturing plant, we are struck at once by the fact that belt shifting is very uncommon, and in fact in many cases, if the manufacturer could obtain them, single purpose machines would be [illegible]

In a shop of the type commonly called production machine shop, we find that an individual machine is tooled up for a single job, and that frequently this machine runs several years without having any change made in the method of manufacture or the speed of either feed or spindle.

Illustrating this point, I was in Flint, Mich., recently and went to our plant to see a screw machine which had been fitted with a mechanical belt shifter. I asked the operator what he thought of the shifter in question and how he found he could shift the belt by means of the shifter. He replied that he had been employed on that particular job for approximately eight months; he thought the belt shifter was very satisfactory, but that he never used it to shift belts with, excepting to satisfy himself that the shifter would work. This condition exists throughout that entire plant.

The field where the belt shifter would give greater service would undoubtedly be in a shop not engaged in production manufacturing, but rather where on account of the special nature of the different jobs, wide variations in the spindle speeds are necessary. This would also apply to drill press operations where the step cone pulleys are not on the machine itself and where one is exposed within twelve or eighteen inches of the floor. Drill presses, excepting where they are used over long periods of time on a single operation, require a large number of changes throughout the working day, owing to the different sizes of drills which may be used on an individual job.

While observing a belt shifter at Flint, several days ago, I noticed that it seemed to be very satisfactory in shifting from high to low; but in shifting from low to high speeds, I noted that the belt curled and that it was very difficult to make this shifting. The plant engineer advised me that the shifter had been thoroughly satisfactory until the belt became oil soaked from long use.

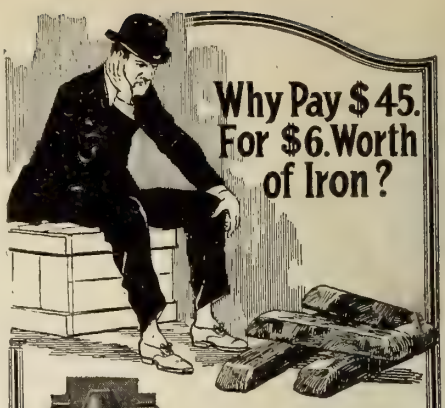
In order, however, that we may obtain accurate information as to the advantages of using mechanical belt shifters over the hand shifting method, and also in order that we may know definitely whether a satisfactory shifter has been developed, our company has arranged to conduct a test on several types of shifters. This test will be strictly impartial, and as a result, we hope to learn whether by using a mechanical shifter the belt is injured, and whether the shifters are satisfactory after the belt has become thoroughly oil soaked and very pliable.

WANTED—CRANES and CUPOLA

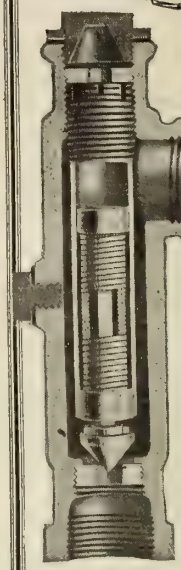
Cranes—Two 40 ft. x 20 ton, 3-motor electric traveling cranes.

Cupola—One modern grey iron cupola about 42 in. inside lining with fan and equipment.

Apply E. Leonard & Sons, Limited
London, Canada



Why Pay $45. For $6. Worth of Iron?



Why pay $1.50, instead of 2¼c a pound for about 286 pounds of superfluous iron in a steam trap? That is literally what you do when you purchase a cumbersome steam trap of the bucket or float type, with its array of troublesome floats, levers, valves, water gauges, bowls, and other unnecessary parts.

The Steam Trap Sarco does everything that the larger, heavier and more complicated traps do. Yet, it has but one moving part and weighs about 6% as much.

STEAM TRAP SARCO

because of its simplicity and light weight, sells for about one-third the price of other makes.

A Sarco saves money in the purchase price as well as in installation cost, for it requires no platform building, no supports, no pit digging. Can be easily and quickly installed at any point on the line.

Let us send you a Sarco on 30 days' trial. If you are willing to part with it at the end of that time, send it back and the trial will cost you nothing.

Write for Booklet J-17 and full information.

SARCO CO., INC.
239 Broadway, New York

Buffalo Cleveland Philadelphia
Chicago Detroit Peacock Bros. Montreal

15 Sales Offices Backed by the 100% Standard of Quality

THE Canadian Fairbanks-Morse Company Limited reaches out to you through its sales houses and offers the service and satisfaction that is assured by its 100% standard of quality and service.

To be able to turn to an institution that dominates its field in the industrial world is to safeguard the character of the merchandise you buy. To deal with an organizationthat is doing business at your very door puts upon the man you know that "responsibility which is the conscience of business."

Every one of these 15 offices has been established to bring to you the full advantages and benefit that have made The Canadian Fairbanks-Morse Co. Limited a national institution. Here in these offices is offered everything mechanical that your business requires — they centralize your purchasing—group your orders—bulk your shipments and send but one invoice. And when you buy from The Canadian Fairbanks-Morse Co. Limited you are guaranteed the 100% standard of quality and service in product and organization.

Make our nearest office your buying centre—our catalogue is your buying guide —our 100% quality seal your guarantee.

The Canadian Fairbanks-Morse Co., Limited

Canada's Departmental House for Mechanical Goods

Halifax St. John Quebec Montreal
Ottawa Toronto Hamilton
St. Catharines Windsor Winnipeg
Regina Saskatoon Calgary
Vancouver Victoria

2

WHY DO YOU ADVERTISE

When You Are Behind In Deliveries ?

THIS seems to be a very natural question, and the answer involves the discussion of a vital policy of this business—a policy that is fundamental.

If we were building a business for to-day our policy would vary from day to day with the temporary changes with which every business has to contend.

But we are building for the time to come and we hope that this business will become many times greater than it is to-day. Without the proper foundation it would undergo violent changes dependent upon temporary national, local or even imaginary conditions.

If we should permit ourselves to become inflated with self-confidence when business conditions are favorable, restricting our selling and advertising activities, and go down in the dumps when conditions are not so favorable, this business would not amount to any more than the existing conditions would make of it.

We say right now, without reservations, that we hope, regardless of how aggressive and efficient our manufacturing department may be, that it will never be able to catch up with our selling organization.

If our efforts should be halted in the middle of the road in times of liberal buying to wait on the manufacturing department, there might come a time when the manufacturing department would have to suspend operations while waiting on the sales organization.

With such a policy we would be running around in a circle, disorganizing one day and reorganizing the next.

The greater the demand for our product, the quicker the turnover for merchants; and the more frequent the turnovers, the larger is the volume of profit.

In this business advertising is a sales policy—the same as our policy of maintaining a sales organization—and we might as well consider the elimination of one as the other. Neither will be eliminated, as this business needs both if we are building for the future.

We hope the idea will never creep into this organization that there will be any let-up in aggressive methods, which might suggest that when business is good there is no occasion for work and when business is poor it is too hard to get.

We constantly have in mind that the American people are much more concerned in their own affairs than in ours, and if we should restrict our selling and advertising activities they will begin to forget us—and this would be our fault.

We are going ahead with the idea of increasing the present momentum in favor of our goods; and if conditions should turn face about, our dealers and ourselves will be in a better position to hurdle obstacles than if we originated a policy for each condition as it arose.

Reprinted from "GRAPHITE," a monthly magazine published by Joseph Dixon Crucible Co., Jersey City, N.J.

Gates Engineering Co.
Limited

MR. JOHN W. GATES wishes to announce the opening of the Gates Engineering Co., Limited. This new organization will be under the direct supervision of Mr. Gates, who is well known as an expert on boiler settings and furnace brickwork.

Consult us when you are about to make any changes on your boiler settings or furnaces. No jobs too large, none too small. Prompt service, quality work, insuring the maximum of efficiency.

Our engineers are at your service. Consult them freely on any problems—without obligation.

Head Office:

348 St. James St., Montreal

Experts

Specializing in Boiler and Furnace Brickwork

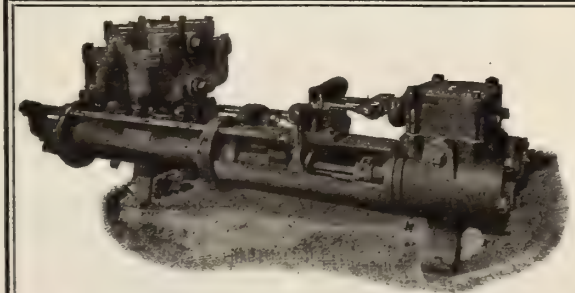
WE WELD EVERYTHING

Leaky Steam Boilers Repaired
Flue Sheets and Flues Welded

WELDING REPAIRS TO ALL MACHINERY GUARANTEED

The Electric Welding Co.

178 Bleury St., Montreal. Phone Main 2300



PUMPS that give

Better Service Longer Service

THE SMART-TURNER MACHINE CO., Limited

Hamilton, Canada

HINTS TO BUYERS

LANCO BALATA BELTING

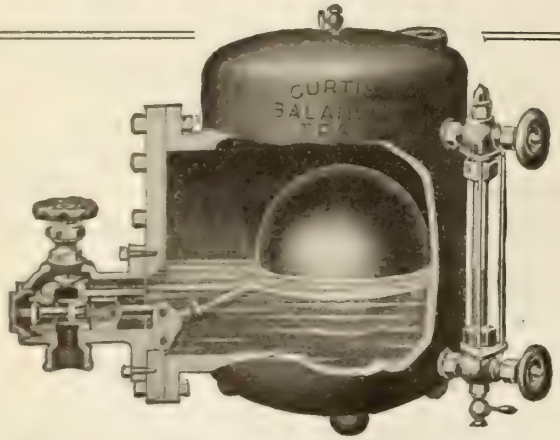
FEDERAL ENGINEERING CO. LTD.
172 JOHN ST
TORONTO

SCANDINAVIA BELTING

IF INTERESTED IN WATER HEATERS BE WISE AND CORRESPOND WITH

THE E.S.MANNY Co
27 COTE ST MONTREAL. CAN.

CURTIS Engineering Specialties



Five Superior Features of the Curtis Trap

1. A perfectly balanced valve.
2. An absolutely frictionless valve.
3. The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4. The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5. Each trap will operate perfectly on pressure varying from one to 250 lbs.

Write for 1920 Catalog of Curtis Engineering Specialties.
Canadian funds are accepted at par at Montreal.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, 14 Mass.
Agencies: 83 Barclay St., New York City
174 N. Market St., Chicago, Ill.

DARLING BROTHERS, LIMITED
Engineers, Manufacturers and Founders
120 Prince Street, MONTREAL, P. Q.
Pumps for any Service—Steam Appliances—Freight Elevators—Webster Vacuum Heating System.

VICTORIA FOUNDRY COMPANY, LIMITED
Engineers, Machine and Foundry Contractors
OTTAWA, CANADA
Special Castings *Forgings*
Pumps, Hoists, Valves, Boiler Fronts, Grate Bars.
Send Blueprints for Quotations. *Write for our latest catalogue.*
Patterns *Machine Work*

Head Fireman Wanted

Extensive experience on Taylor and other types of underfeed stokers. 7,000 horse-power plant. Give age, experience, reference and wages.

Box 72220

Largest manufacturers of white metals in the world

Solder
Wire Solder
Ingot Metals

DYNAMO GENUINE BABBITT
FOR
Heavy Duty Dynamo Bearings

Lead Wool
Lead Sheets
Lead Traps
and Bends

HOYT METAL COMPANY
MONTREAL TORONTO WINNIPEG

DEPARTMENT OF LABOUR

Ontario Government

Minister: Hon W. R. Rollo **Deputy Minister: W. A. Riddell, Ph.D.**

NOTICE TO STATIONARY AND HOISTING ENGINEERS AND STEAM PLANT OWNERS

Everyone operating a **Stationary** steam plant of 50 B.H.P. or over, and everyone operating a **Hoisting** steam plant working at a pressure of 20 pounds or over, irrespective of horsepower and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a certificate from the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

After January 1, 1920, all stationary steam plants in the Province of Ontario must be registered with the Board of Stationary and Hoisting Engineers. Application forms will be forwarded upon request.

All applications should be mailed to the Chairman of the Board. W. C. McGhie, Department of Labour, 15 Queen's Park, Toronto.

NOTICE TO MANUFACTURERS, DEALERS AND USERS OF STEAM BOILERS

All steam boilers built in, or entering, the Province of Ontario, and boilers exchanged or repaired, are subject to Government Inspection as prescribed in the Steam Boilers' Act, 3 George V., ch. 61.

Before any work of repair or alteration is commenced on any boiler, notice must be sent to the Department stating the nature and extent of the repairs or alterations proposed to be made. If the Chief Inspector should consider such repairs or alterations of an extensive character, the boiler must be inspected in accordance with the Regulations by an Inspector authorized under the Act.

All communications should be addressed to the Steam Boiler Branch, Department of Labour, 15 Queen's Park, Toronto. D. M. Medcalf, Chief Inspector of Steam Boilers.

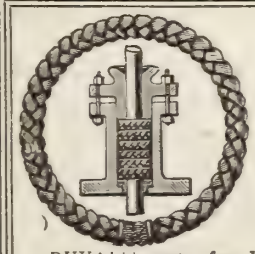
MONCRIEFF'S

"UNIFIC" GAUGE GLASSES

The British Navy uses "Moncrieff's" "Unific". It is the kind that lasts.
It is a special feature of the "Unific" that it does not readily corrode; resists extreme changes of temperature and withstands the highest working steam pressure. In consequence it has a long life, justifies a higher price than the soda lime glasses, and is, indeed, the more economical purchase in the end.

Write for our catalogue.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND
Canadian Representative:
W. J. WALL 134-136 Bleury St., Montreal



DUVAL'S METALLIC PACKING

for

ALL CLASSES OF ENGINES

and the

Highest Superheated Steam

DUVAL'S lasts for YEARS without renewal and keeps the rods in perfect condition. It is placed in the glands the same way as ordinary soft packings. Over 600,000 glands packed.

"BENHYCO" JOINTING FOR STEAM AND HYDRAULIC JOINTS. Supplied 48" square, 1/32" thick and up.
Stock carried in Montreal.

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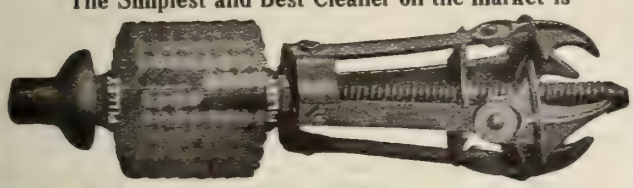
LAURIE & LAMB

Board of Trade Building, Montreal

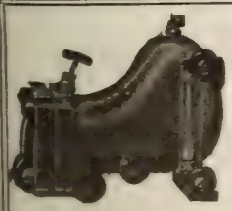
The Simplest and Best Cleaner on the market is



PILLEY'S

Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by

PILLEY PACKING AND FLUE BRUSH MFG CO
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.



McDANIEL IMPROVED STEAM TRAP

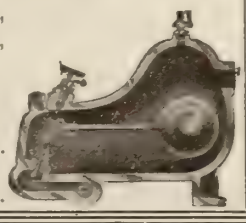
FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.



THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

ECONOMIC Carling BLOWERS SUPERIOR

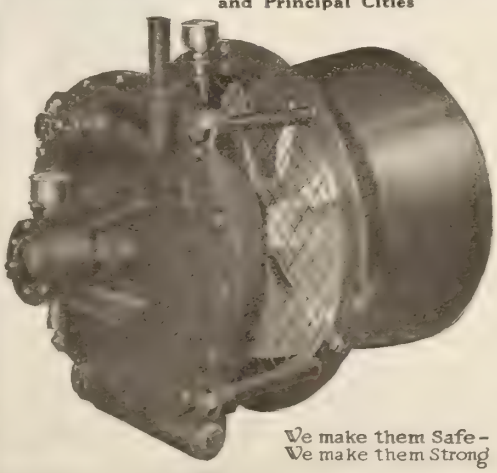
Carling Turbo Blowers

For burning the lowest grades of coal successfully, getting all the heat value from the fuel. For positive draft with Automatic Control and steady steam pressure. For obtaining the ultimate capacity from the boiler.

Carling Blowers are low in first cost, easy to install and make a quick return on the investment. We will be pleased to show you why it pays to use Carling products.

Write to-day. Try at our expense.

CARLING TURBINE BLOWER COMPANY
Engineers and Manufacturers **WORCESTER, MASS**
Canadian Representatives: Green's Economizer Limited, Toronto and Principal Cities



Turbine Undergrate Blowers,
Centrifugal Blowers and Exhausters,
Small Power Turbines,
Damper Regulators and Grates

We make them Safe—
We make them Strong

THE ANDERSON
MODEL "D" STEAM TRAP
Allows No Escape Of Live Steam.

The valve is always locked with at least three inches of water, thus the escape of live steam is rendered impossible.

The **Anderson** will lift water at any back pressure five pounds less than the pressure at the trap:

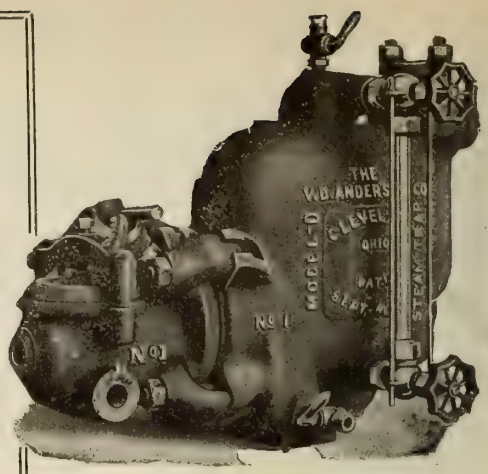
A strainer and sediment chamber prevents sediment and scale from getting into the valve.

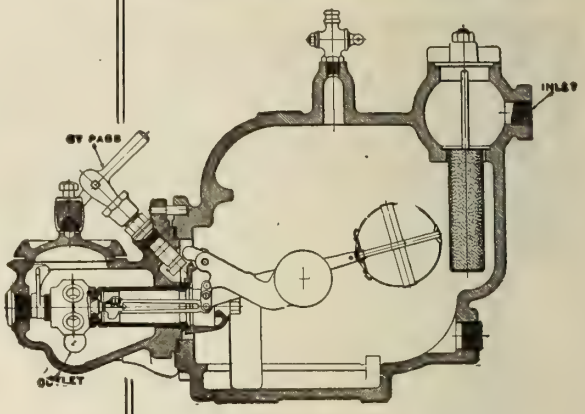
To ascertain whether the trap is working properly, a glance at the gauge glass, fitted to the trap, is sufficient.

The valve and valve seat can both be removed without breaking a steam joint or pipe connection.

The **Anderson Model "D" Steam Trap** is accurate in every detail. Built of materials best suited for the purpose. Every part interchangeable.

Full particulars of these and other points will be forwarded immediately upon receipt of your request.



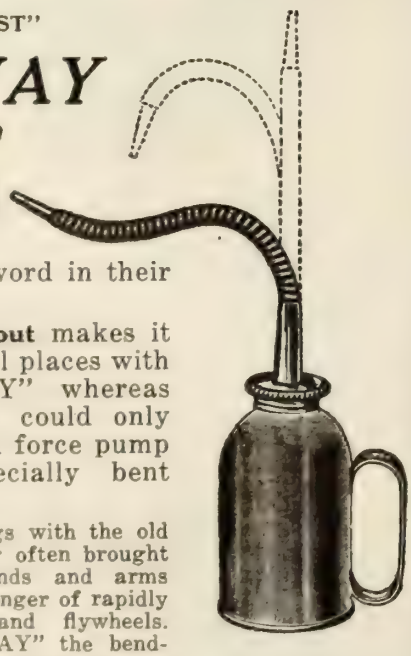


The V. D. Anderson & Company

1935 West 96th St., Cleveland, Ohio.

"SAFETY FIRST"

ALL-WAY
RAILROAD
OILERS



are the latest word in their line.

The **flexible spout** makes it possible to oil all places with one "ALL-WAY" whereas previously they could only be reached with force pump cans with specially bent spouts.

Lubricating bearings with the old straight spout oiler often brought the engineer's hands and arms very close to the danger of rapidly revolving gears and flywheels. With the "ALL-WAY" the bending of the spout removes this danger. Sizes No. 4, 1 pint—10 in. spout. No. 5, 1 quart—11 in. spout.

If your dealer cannot supply you write us.

We also manufacture the well-known "All-Way" Oil Can—saves you 50% of your oil bill.

THE ALL-WAY OILER MFG. COMPANY
196 KING STREET WEST - TORONTO, ONTARIO

TEMPERATURE, PRESSURE & TIME CONTROLLERS, FLOW METERS

BOILERS & TANKS, WATER FILTERS THERMOMETERS, GAUGES

E. J. Philip & Sons, Engineers, 57 Queen Street, West
Toronto, Canada

THE EMPIRE STEAM TRAP IS A WONDER
WRITE FOR CATALOGUE

THE E.S.MANNY Co

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Tuck's Genuine Packings

Asbestos and Others for High Pressure, Steam, Hydraulic and Other Purposes.

Insist Upon Having the TRADE Packing Bearing Our MARK

TUCK & COMPANY, LIMITED

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Canadian Representative:
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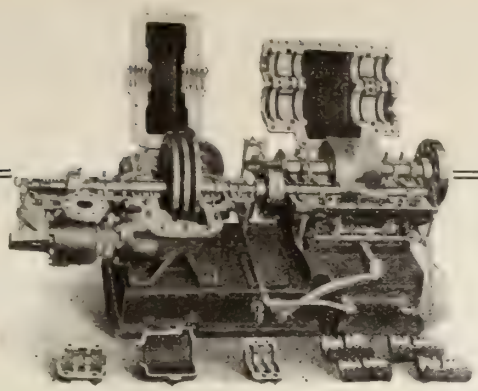
Stocks Carried in All Sizes TEL. No. MAIN 2387



The Design of Moore Steam Turbines Prevents Steam Leaks

Ample surfaces at the joints have been provided to prevent leakage of steam—also the number of vertical joints have been reduced to a minimum. In a turbine having numerous vertical joints it is almost impossible to prevent leakage and consequent loss of efficiency in operation.

The careful designing to prevent all steam leakage is but one feature of Moore Steam Turbines. Send for our booklet. It explains fully the others.

Moore Steam Turbine Corporation
Wellsville New York U.S.A.

HOMESTEAD VALVES

Positive-Acting Quarter-Turn Valves

Homesteads are "positive-acting" in each position. When open there is a straight, unobstructed flow. When closed they are positively tight. All Homesteads are constructed with the patented Homestead principle, which locks the valve tightly to the seat when closed.

One-quarter of a turn only is necessary to open and close Homestead Valves. Adopt them. You'll save time, trouble and expense.

Our catalog contains some interesting information.

Homestead Valve Mfg. Company
Homestead, Pa.

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LIMITED
HEAD OFFICE & WORKS
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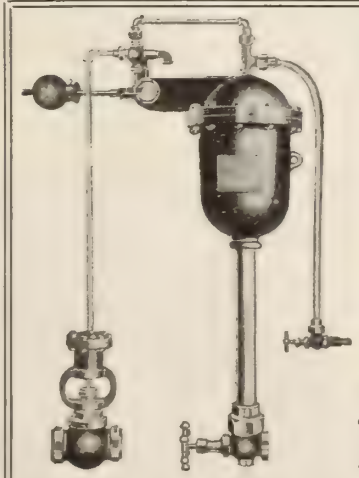
Branches: Toronto, Winnipeg, Vancouver.
Sales Offices : Halifax, Quebec, Ottawa, Calgary



The Safe Way

Vigilant Water-Feed Regulators

There need be no worry on the part of you or your men in feeding boilers.

The "Vigilant" will automatically hold the water level at middle gauge—the safe, desirable point at which the boiler contains the maximum steam liberating surface.

Write for full particulars to-day.

The Chaplin-Fulton Mfg. Co
28-34 Penn Avenue, Pittsburgh, Penn.

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If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

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Empire Mfg. Co., Ltd., London, Ont.
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Northern Electric Co., Ltd., Montreal.

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D. K. MacLaren, Ltd., Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.
Empire Mfg. Co., Ltd., London, Ont.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Goodyear Tire & Rubber Co., Toronto.
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D. K. MacLaren, Ltd., Montreal, Que.
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BELT HOIST
Can. [illegible] Montreal

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D. K. MacLaren, Ltd., Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

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D. K. MacLaren, Ltd., Montreal, Que.
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BLOWERS, FANS
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Coppus Eng. & Equipt. Co., Worcester, Mass.
Sturtevant Co., B. F., Toronto, Can.

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BLOWERS, MECHANICAL SOOT
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BOILER MOUNTINGS
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BOILER HOUSE ACCESSORIES
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Sexton Boiler Setting Co., W. R., Toronto

BOILER SETTINGS
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Sexton Boiler Setting Co., W. R., Toronto

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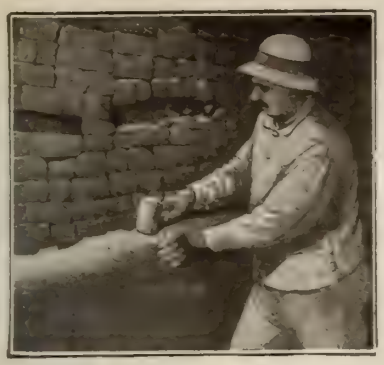

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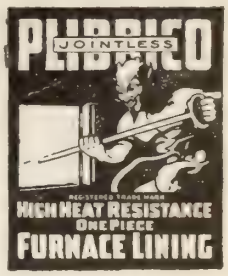

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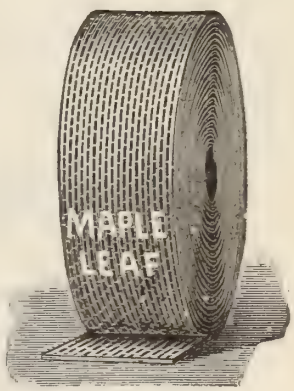

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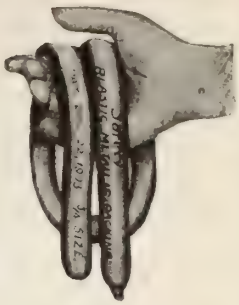

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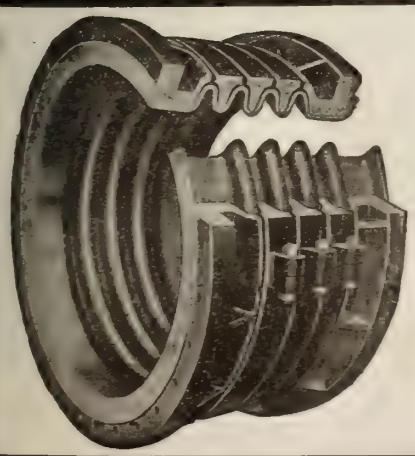

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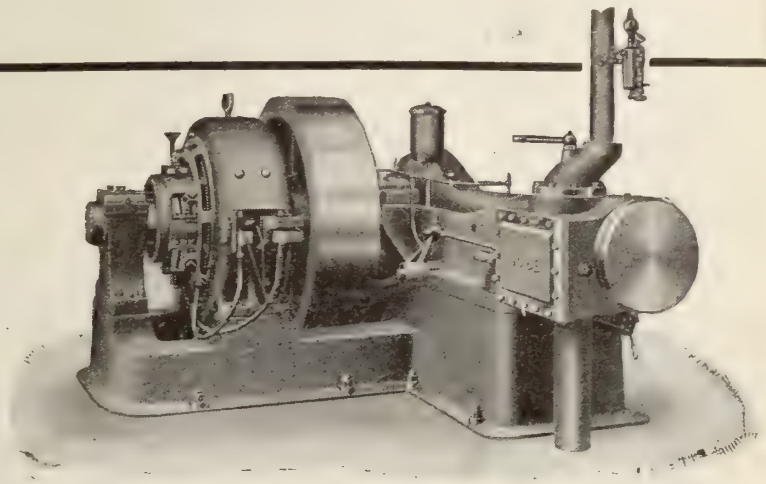

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Jas. Morrison Brass Mfg. Co., Toronto.

OIL STORAGE AND DISTRIBUTING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

OIL TESTING INSTRUMENTS
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

OILING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.
Lunkenheimer & Co., Cincinnati, O.

OXY-ACETYLENE AND OXY-HYDROGEN WELDING AND CUTTING EQUIPMENTS
Holden Co., Ltd., The, Montreal.

PACKING, AMMONIA, STEAM AND WATER
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Johns-Pratt Co., The, Hartford, Conn.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ASBESTOS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, ALL KINDS
Garlock Packing Co., Hamilton.
Goodyear Tire & Rubber Co., Toronto.

PACKING, ENGINE
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING FIBRE
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.

PACKING, HYDRAULIC
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber Co., Limited.
Sarco Co., Inc., New York.

PACKING, LEATHER
Garlock Packing Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.

PACKING, METALLIC
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, PISTON
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, ROD
Shell Bar Boico Supply, Ltd., Toronto.
Can. H. W. Johns-Manville Co., Toronto.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Sarco Co., Inc., New York.
Steel Mill Packing Co., Windsor, Ont.

PACKING, RUBBER
Gutta Percha & Rubber Ltd. Toronto.
Goodyear Tire & Rubber Co., Toronto.
Sarco Co., Inc., New York.

PACKING, SHEET
Can. H. W. Johns-Manville Co., Toronto.
Shell Bar Boico Supply, Ltd., Toronto.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Gutta Percha & Rubber, Ltd., Toronto.
Jenkins Bros., Ltd., Montreal.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Valve Engineering Company.

PACKING, VALVE STEM
Crane Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Gutta Percha & Rubber, Ltd., Toronto.
Johns-Pratt Co., The, Hartford, Conn.
Sarco Co., Inc., New York.
Shell Bar Boico Supply, Ltd., Toronto.

PAINTS, OIL, STORAGE AND HANDLING SYSTEMS
S. F. Bowser Co., Ltd., Toronto, Ont.

PAINTS
Shell Bar Boico Supply, Ltd., Toronto.

PATTERNS, WOOD
J. C. Wilson Mfg. Co., Ltd., Belleville.

PATTERNS, IRON
J. C. Wilson Mfg. Co., Ltd., Belleville.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons, Pittsburgh, Pa.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PILLOW BLOCKS
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

PIPE COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulat'n Co., Montreal

PIPE, BLACK AND GALVANIZED
Crane's Limited, Montreal.

PIPE, BOIL, AND FITTINGS
Crane's Limited, Montreal.

PIPE, STEEL
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE, ACID RESISTING
Jenkins Bros., Ltd., Montreal.

PIPES, WATER
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PIPE JOINT COMPOUNDS
Crane's Limited, Montreal.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.

PLATE WORK
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh.

PNEUMATIC TOOL LUBRICANTS
Holden Co., Ltd., The, Montreal.

PNEUMATIC HAMMERS
Holden Co., Ltd., The, Montreal.

PLUMBING SUPPLIES
Empire Mfg. Co., Ltd., London, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

PNEUMATIC TOOLS
Holden Co., Limited, The, Montreal.

POWER HOUSE CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

POWER LIGHT PLANTS
Northern Electric Co., Ltd., Montreal.

POWER, TRANSMISSION MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Mfg. Co., Montreal, Canada.
MacGovern & Co., Inc., Montreal.
MacGovern & Co., New York.
Ministry of Munitions, London, England.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.
J. C. Wilson Mfg. Co., Ltd., Belleville.

POWER PUMPS (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PRESSES
Boving Hydr. & Eng. Co., Ltd., Lindsay.

PRESSES, HYDRAULIC
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.

PROJECTOR, FLOOD LIGHTING
Holden Co., Limited, The, Montreal.

PROPELLER BLADES, BRONZE
Empire Mfg. Co., Ltd., London, Ont.

PULLEYS
D. K. MacLaren, Ltd., Montreal, Que.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
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Goldie & McCulloch Co, Galt.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.
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PULLEYS, BELT
Waterous Engine Works Co., Brantford.
D. K. MacLaren, Ltd., Montreal, Que.

PULLEYS, FRICTION CLUTCH
Can. Link-Belt Co., Toronto, Ont.

PULP MILL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Jeffrey Mfg. Co., Montreal, Canada.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
The Mason Regulator & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Smart-Turner Machine Co., Ltd., Hamilton
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Brothers, Ltd., Montreal, Que.
Jeffrey Manufacturing Co., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS
Mason Reg. & Eng. Co., Ltd., Montreal.
Coppus Eng. & Equipt. Co., Worcester.
Pratt & Cady, Hartford, Conn.

PUMPS, AIR
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Holden Co., Limited, The, Montreal.
Laurie & Lamb, Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, ACID
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, BOILER FEED
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Can. Steam Boiler Equipt. Co., Toronto.
Darling Bros, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Ltd., Hamilton

PUMPS, CONTRACTORS'
Boving Hydr. & Eng. Co., Ltd., Lindsay.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AND GASOLINE), CURB
S. F. Bowser Co., Ltd., Toronto, Ont.

PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Coppus Eng. & Equipt. Co., Worcester.
Darling Bros., Montreal.
Escher, Wyss Co., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPS, DUPLEX
Darling Brothers, Ltd., Montreal, Que.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek.
Darling Brothers, Ltd., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS
Norwalk Iron Wks., South Norwalk, Conn.
Pratt & Cady, Hartford, Conn.

PUMP GOVERNORS AND REGULATORS
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND AND POWER
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, HAND (OIL, GASOLINE)
S. F. Bowser Co., Ltd., Toronto, Ont.
Pratt & Cady, Hartford, Conn.

PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton.

PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, OIL
American Steam Pump Co., Battle Creek.
S. F. Bowser Co., Ltd., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER
American Steam Pump Co., Battle Creek.
Boving Hydr. & Eng. Co., Ltd., Lindsay
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Pratt & Cady Co., Inc., Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.

PUMPS, STEAM TURBO
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Escher, Wyss & Co., Montreal, Que.
Pratt & Cady, Hartford, Conn.

PUMPS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
Williams Machinery Co., A. R., Toronto.

PUMPS, TRIPLEX
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, VACUUM
American Steam Pump Co., Battle Creek.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Holden Co., Ltd., The, Montreal.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS (OIL AD GASOLINE), SELF-MEASURING
S. F. Bowser Company, Ltd., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

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Mason Reg. & Eng. Co., Ltd., Montreal.
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Smart-Turner Machine Co., Hamilton.

PYROMETERS
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Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co, Rochester, N.Y.
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RADIATORS
Crane's Limited, Montreal.
Empire Mfg. Co., Ltd., London, Ont.

RADIATOR TRAPS
C. A. Dunham Co., Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Sarco Co., Inc., New York, N.Y.

RADIATOR AIR VENTS
C. A. Dunham Co. Ltd., Toronto, Ont
Jas. Morrison Brass Mfg. Co., Toronto.
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RAGS
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S. F. Bowser Company, Ltd., Toronto.

REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
W. S. Sexton Boiler Setting Co., Toronto.
York Manufacturing Co., York, Pa.

RECEIVERS, AIR
MacKinnon, Holmes & Co., Sherbrooke.

RECLAIMING, SYSTEMS FOR OIL
S. F. Bowser Company, Ltd., Toronto.

RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
Yarnal-Waring Co., Philadelphia, Pa.

RECORDERS, CARBON, DIOXIDE
Jos. W. Hays Corp., Michigan City, Ind.
Sarco Company, Inc., New York.

RECORDERS, DRAFT
Jos. W. Hays Corp., Michigan City, Ind.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

RECORDERS, PRESSURE
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.

REFRIGERATING MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Can. Refrigeration Co., Montreal.
Norwalk Iron Wks., South Norwalk, Conn.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

REFUSE DESTRUCTOR
Laurie & Lamb, Montreal.

REGISTERING MEASURES
S. F. Bowser Company, Ltd., Toronto.

REGULATORS, AUTOMATIC, BOILER
McDonough, J., 23 Markham St., Toronto

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Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
D'Este Co., Julian, Boston, Mass.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

REGULATORS, PRESSURE,
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Crane's Limited, Montreal.
C. A. Dunham Co., Ltd., Toronto, Ont.
D'Este Co., Julian, Boston, Mass.
Mason Reg. & Eng. Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.
Taylor Instrument Co, Rochester, N.Y.

REGULATORS, LIQUID LEVEL
C. J. Tagliabue Mfg. Co., Brooklyn, N.Y.

REGULATORS, TEMPERATURE
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Co., Inc., New York, N.Y.
Taylor Instrument Co., Rochester, N.Y.

RETORTS
MacKinnon Steel Co., Sherbrooke, Que.

REVOLVING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.

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Empire Mfg. Co., Ltd., London, Ont.
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ROLLS, CRUSHING
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

RUBBER CEMENT TANKS AND PUMPS
S. F. Bowser Company, Ltd., Toronto.

RUBBER MILL DRIVES
Can. Link-Belt Co., Toronto, Ont.

SAFES
Can. Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.

SAW MILL CONVEYORS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.

SCREENING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto.
Frank Gilman, Birmingham, Eng.

SCREWED, FLANGED AND MALLEABLE SCREWED
Crane's Limited, Montreal.

SEPARATORS, STEAM
Mason Reg. & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
H. Mueller Mfg. Co., Ltd., Sarnia.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Robb Engineering Works, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton.
Watson & McDaniel Co., Philadelphia.

SHAFTING
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

SMELTING LININGS
W. R. Sexton Boiler Setting Co., Toronto

SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Robb Engineering Works, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

SOLDER, BAR WIRE, ETC.
Host Metal Co., Toronto.

SOCKETS, WIRE ROPE
J. H. Williams & Co., Brooklyn, N.Y.

SOOT BLOWERS
Diamond Specialty Co., Windsor, Ont.

SPECIAL MACHINERY
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Waterous Engine Works Co., Brantford.

SPEED INDICATORS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
C. S. Starrett Co., Athol, Mass.

SPEED REDUCING GEARS
Can. Link-Belt Co., Toronto, Ont.

SPRAY WATER COOLING SYSTEMS
E. B. Badger & Sons Co., Boston, Mass.

SPRAY AIR WASHERS
E. B. Badger & Sons Co., Boston, Mass.

SPROCKET CHAIN ATTACHMENTS
Can. Link-Belt Co., Toronto, Ont.
Jeffrey Mfg. Co., Montreal, Canada.
Waterous Engine Works Co., Brantford.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford

SPROCKETS, COMPENSATING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SPRING
Morse Chain Co., Ithaca, N.Y.

SPROCKETS, SILENT CHAIN
Morse Chain Co., Ithaca, N.Y.

SPUR WHEELS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Goldie & McCulloch Co., Galt.
Can. Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.

STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
MacKinnon Steel Co., Ltd., Sherbrooke.
Hamilton Co., Wm. Peterboro, Ont.

STAND PIPES, STEEL
MacKinnon Steel Co., Ltd., Sherbrooke.

STEAM SPECIALTIES
Can. Fairbanks-Morse Co., Montreal.
Can. Fairbanks Co., Toronto.
Cole Ltd., Geo. W., Toronto.
Crane's Limited, Montreal.
Darling Brothers, Montreal.
D'Este Co., Julian, Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Mason Reg. & Eng Co., Ltd., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
Yanall-Waring Co., Philadelphia, Pa.

STEAM TRAP TOOLS
Crane's Limited, Montreal.

STEEL BARRELS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL DRUMS
Smart-Turner Machine Co., Hamilton.
Scaife & Sons Co., Wm., Pittsburgh, Pa.

STEEL F. J. A. B. ROCK DRILL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL F. J. A. B. CARBON TOOL
Lincoln Electric Co. of Can., Ltd., Toronto

STEEL PLATE WORK
Hamilton Co., Wm., Peterboro, Ont.

STEEL, CONTRACTORS' STRUCTURAL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.

STOKERS
Babcock & Wilcox, Ltd., Montreal.
Detroit Stoker Co., Detroit, Mich.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Leitch Co., A. S., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass

STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Darling Bros., Ltd., Montreal, Que.
Mason Reg. & Eng. Co., Ltd., Montreal.
Sarco Company, Inc., New York.
Smart-Turner Machine Co., Hamilton.

STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Superheater Co., Ltd., The, Montreal.

SWITCH AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto.

SWIVELS, HOOK
J. H. Williams & Co., Brooklyn, N.Y.

SYPHONS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

TACHOMETERS
Boving Hydr. & Eng. Co., Ltd., Lindsay.
Can. H. W. Johns-Manville Co., Toronto.
Schaeffer & Budenberg Mfg. Co., Brooklyn

TANKS, AMMONIA
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.

TANKS, BLOW-OFF
Mason Reg. & Eng. Co., Ltd., Montreal.
Darling Bros., Montreal.
Waterous Engine Works Co., Brantford.

TANKS, BRINE
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Ltd., Sherbrooke.
Waterous Engine Works Co., Brantford.
York Manufacturing Co., York, Pa.

TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
MacKinnon Steel Co., Sherbrooke, Que.
York Manufacturing Co., York, Pa.

TANKS, GASOLINE
S. F. Bowser Co., Ltd., Toronto.
Imperial Oil, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.

TANKS, OIL
Boving Hydr. & Eng. Co., Ltd., Lindsay.
S. F. Bowser Company, Ltd., Toronto.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
MacKinnon Steel Co., Ltd., Sherbrooke.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.
Waterous Engine Works Co., Brantford.

TANKS (OIL, KEROSENE, GASOLINE)
S. F. Bowser Company, Ltd., Toronto.
MacKinnon Steel Co., Sherbrooke, Que.
Wm. B. Scaife & Sons Co., Pittsburg, Pa.

TANKS, STEEL
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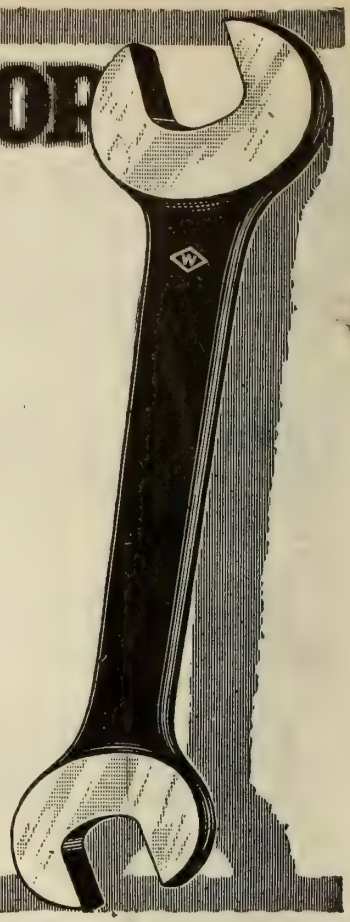

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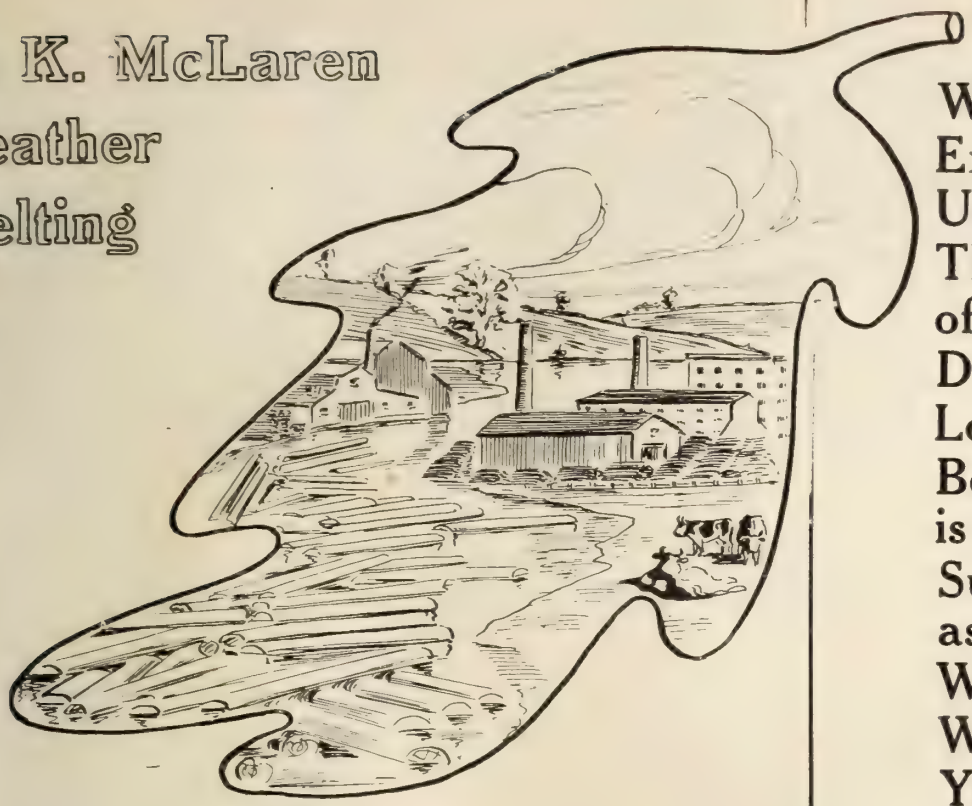

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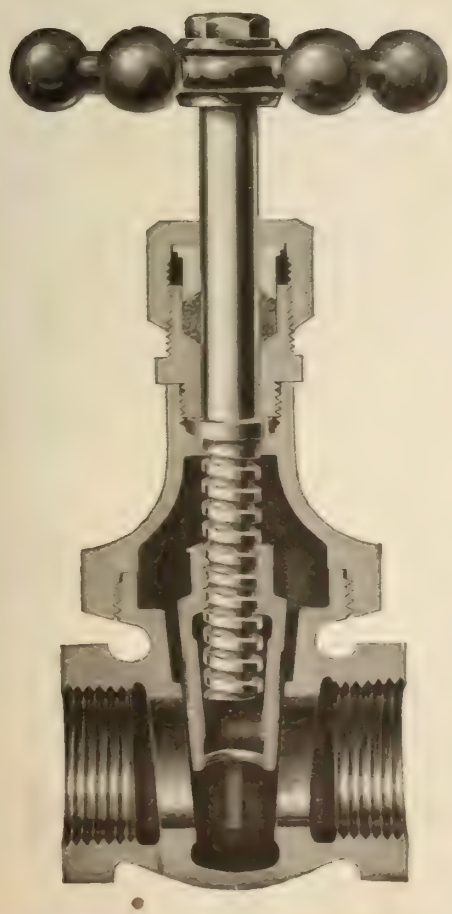
PENBERTHY

Brass Gate Valve



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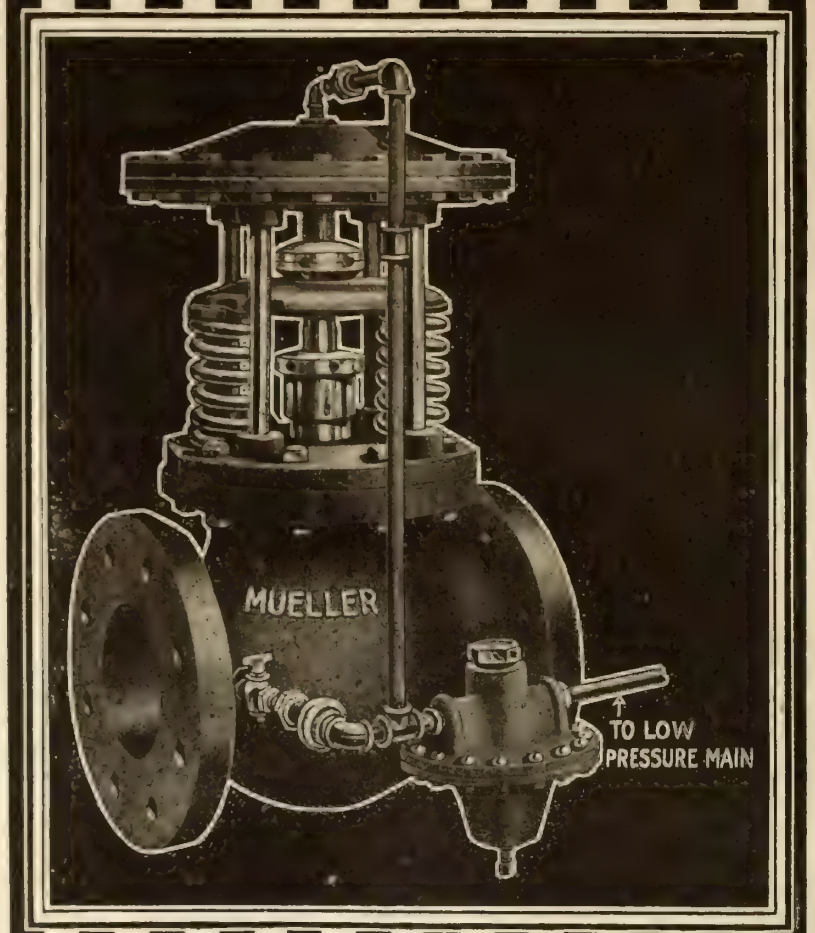

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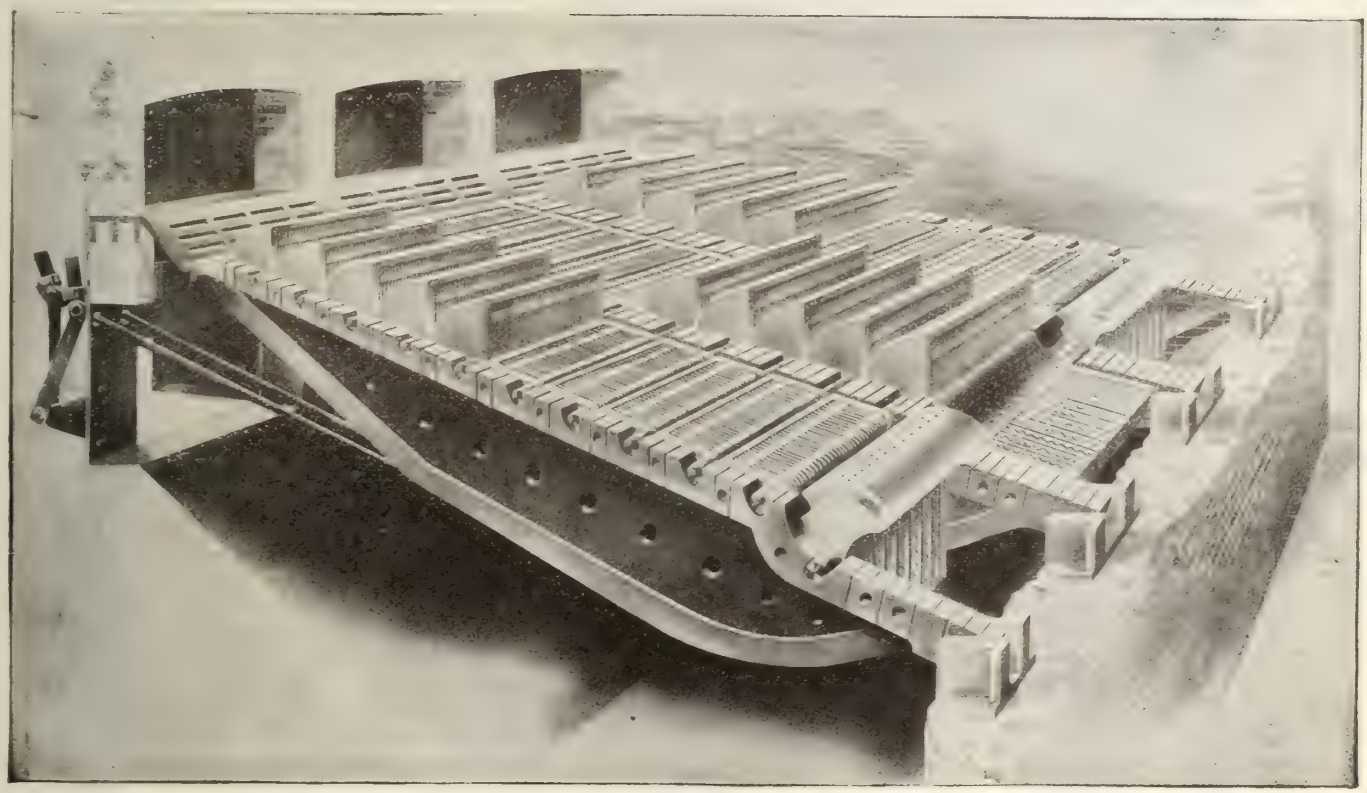

Waterous

BRANTFORD, ONTARIO, CANADA

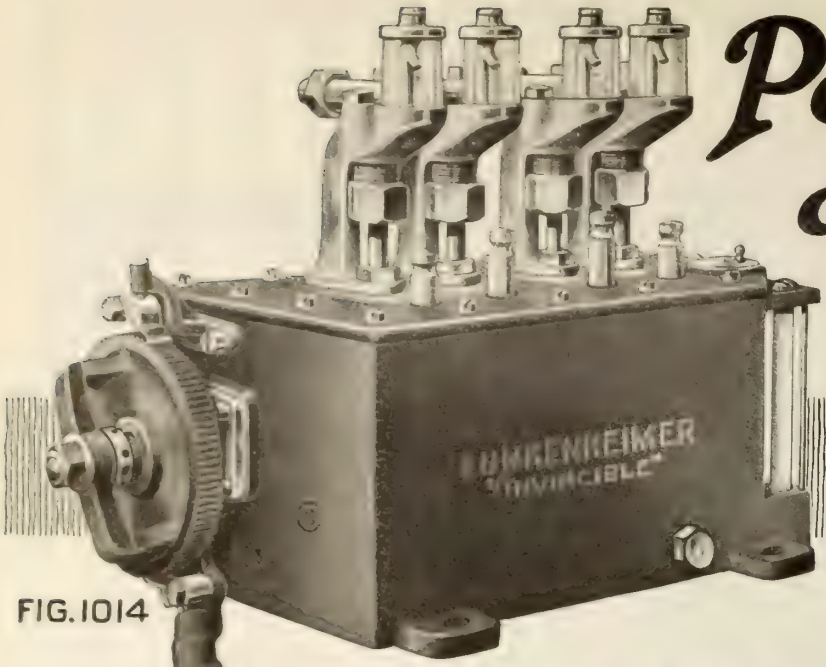

FIG. 1014

Positive Oil delivery— in measured quantity.

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For Steam, Gas and Oil Engines, Pumps and Compressors,

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Fig. 1014—"Invincible" is mechanically operated and is made in one to four feeds with capacities from one quart to one gallon.

Fig. 482—"Senior" is a double connection hydrostatically operated lubricator made in capacities from ¼ pt. to 1 gal.

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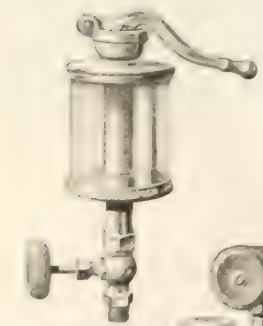

FIG. 495

FIG. 486

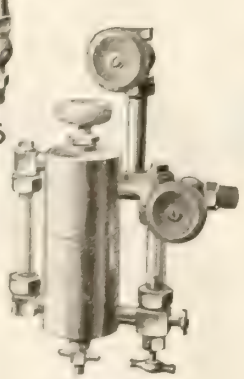

FIG. 482

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GENUINE OAK
It's Your Guarantee
It's in the Grip—Not Tension!
If your belts are slipping, tightening them won't help any. Extra tension, as you know, plays particular havoc with belting, besides straining the shaftings and wearing out bearings.
It's grip that's needed to keep Power House transmission costs down, and the gripping power of any leather belt depends entirely on the tanning process.
That's why D. K. McLaren's Belting hugs the pulley with a grip that can't slip—because it's all Oak-Tanned by the genuine British process. It's a long-time process and generally considered too expensive to use, but every foot of D. K. McLaren's Belting is made flexible and practically stretchless by this method—that Oak Leaf says so.
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LIMITED
Toronto, Ont., 194 King St. W
St. John, N.B., 90 Germain St.
Vancouver, B.C., Gorman's Ltd., 1155 Homer St.
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An economy when buying machines or supplies

Because the Canadian Fairbanks-Morse Co., Limited, is "Canada's Departmental House for Mechanical Goods"—selling everything your business needs in the highest-grade machinery and supplies—it offers you all the savings of grouped orders and bulk shipments.

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Make our nearest Branch your buying centre and our catalog your guide to the most reliable mechanical goods.

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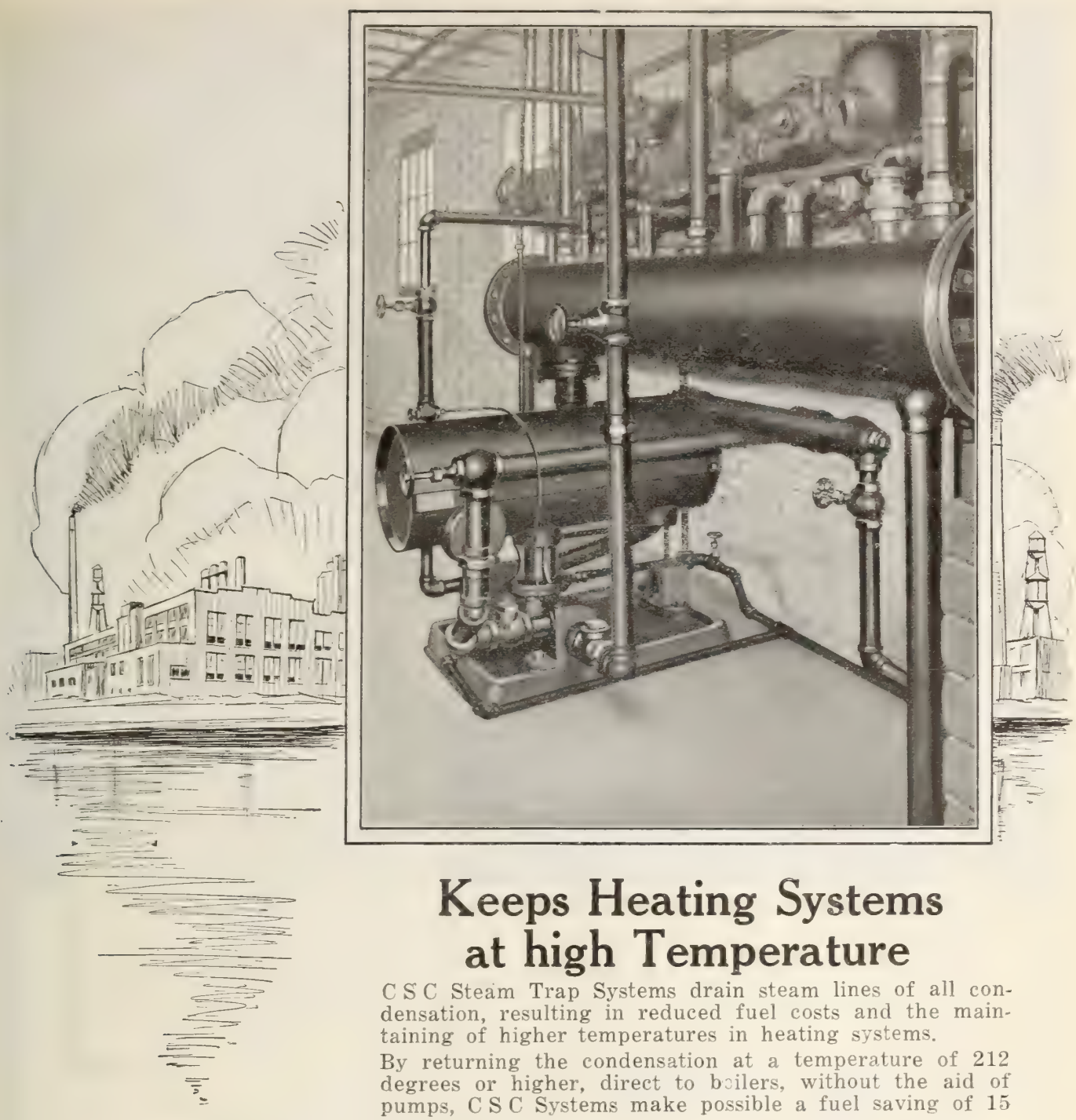


Keeps Heating Systems at high Temperature

C S C Steam Trap Systems drain steam lines of all condensation, resulting in reduced fuel costs and the maintaining of higher temperatures in heating systems.

By returning the condensation at a temperature of 212 degrees or higher, direct to boilers, without the aid of pumps, C S C Systems make possible a fuel saving of 15 per cent. or more.

If you have a heating problem—a building difficult to heat because of condensation in steam lines—you are assured that the C S C Trap System will keep that heating system at topmost efficiency. Write to-day for our booklet in which the C S C System is described in detail.

Canadian Sirocco Company, Limited, Windsor, Ontario

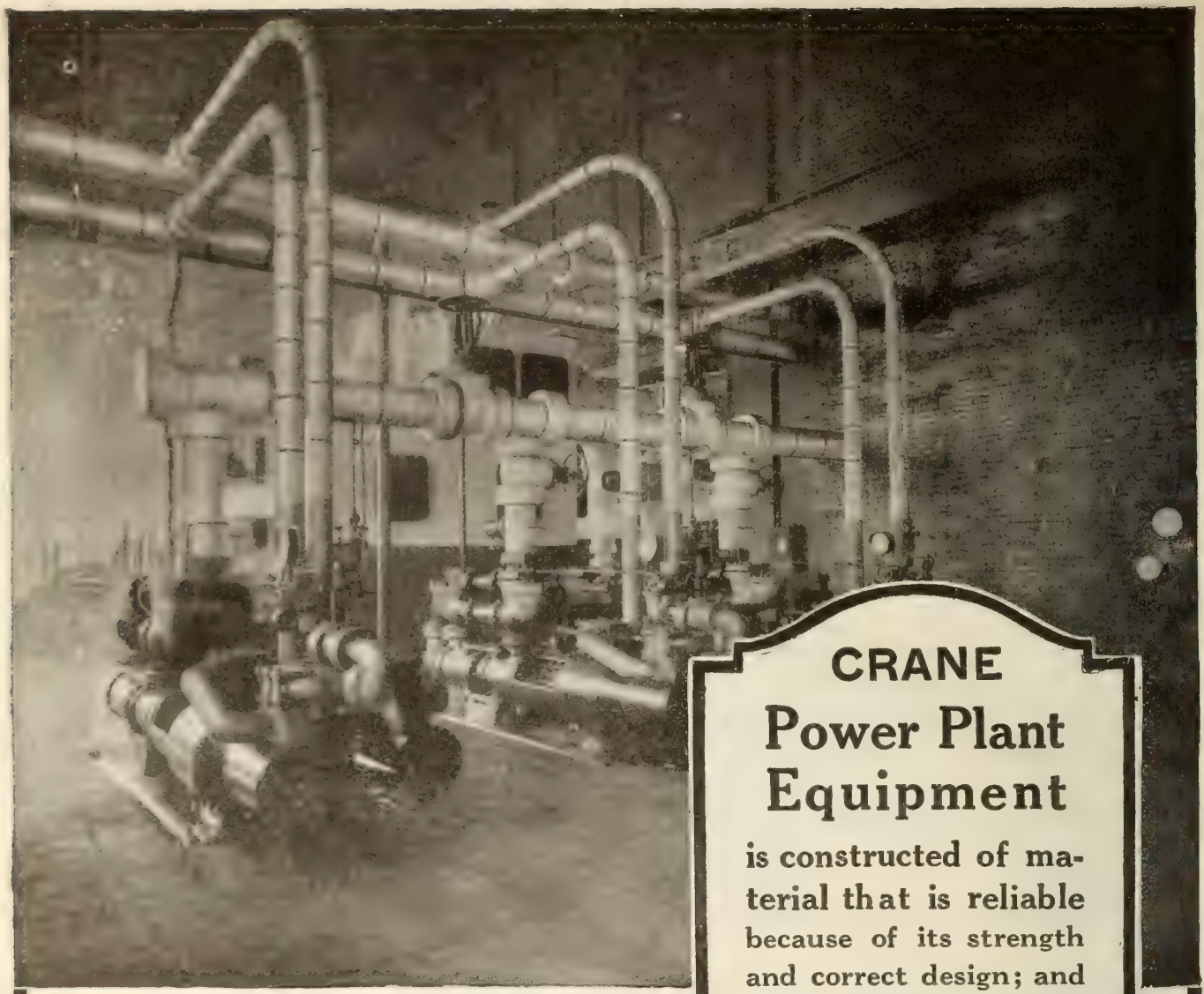
Branch Offices in all Principal Cities

"Sirocco" Products

TRADE MARK

BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT



CRANE

Power Plant Equipment

is constructed of material that is reliable because of its strength and correct design; and when properly installed makes a piping system having long life and low maintenance cost.

Manufacturers of Valves, Fittings and Piping Equipment for all pressures and purposes —and distributors of Pipe, Plumbing and Heating Supplies,

CRANE
LIMITED
HEAD OFFICE AND SHOW ROOMS
386 BEAVER HALL SQUARE
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Branches and Sales Offices in all principal cities.

Works:
1280 St. Patrick St., Montreal.

17a

Fig. 106
JENKINS BRASS GLOBE VALVE
Standard Pattern

Suitable for 150 pounds working steam pressure, 250 pounds working water pressure.

INSTALL JENKINS VALVES

They'll open easily and close tightly. They won't leak. They'll withstand severe service, rough usage and careless handling. They're made that way.

The dependability and longevity of Jenkins Valves are due to careful construction in every detail and to the Jenkins Valve Disc which prevents wearing metal to metal action between disc and seat.

Genuine Jenkins Valves are made of brass, iron and cast steel—types and sizes to meet every requirement. Like the genuine Jenkins Discs they are known by the Jenkins Diamond Trade Mark.

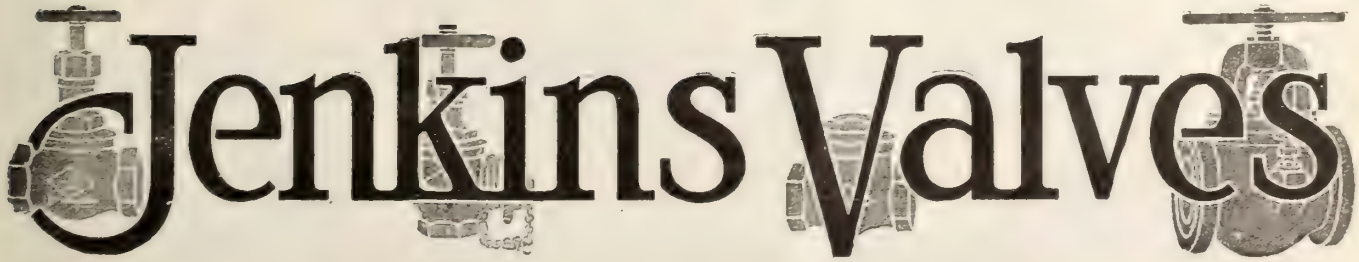
Look for it when buying

JENKINS BROS. LIMITED

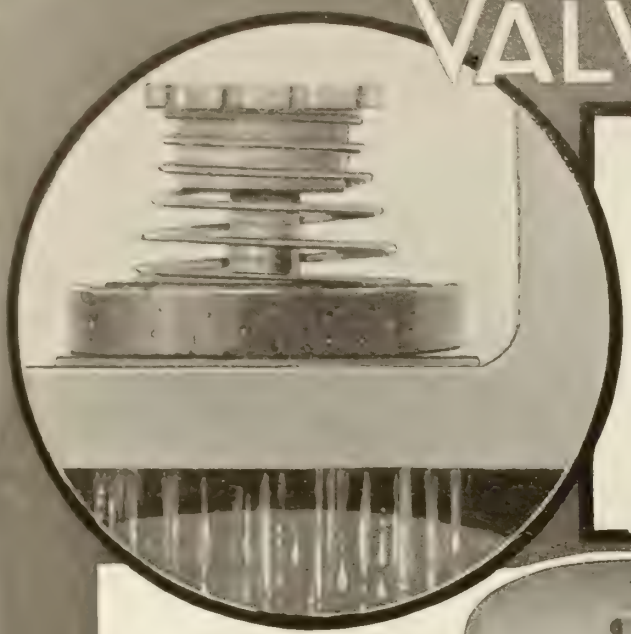
103 St. Remi St., Montreal

Toronto Winnipeg Vancouver

European Branch:
6 Great Queen St., Kingsway, London, W. C. 2., England



VALVE LEAKAGE



When slip due to valve leakage in the water end is added to thermal losses in the steam end the final efficiency of the average pump becomes very low.

To be successful, pump valves must be selected to suit the diversified requirements of pumping service.

Garlock Pump Valves are scientifically compounded and prepared for each special service.

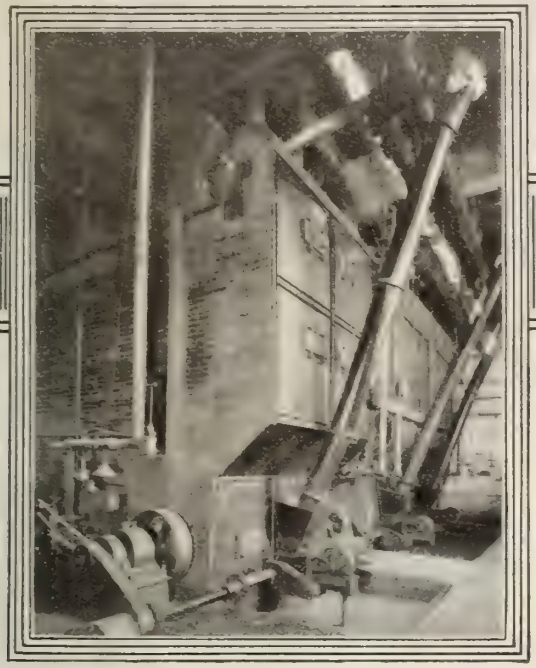
GARLOCK PACKINGS

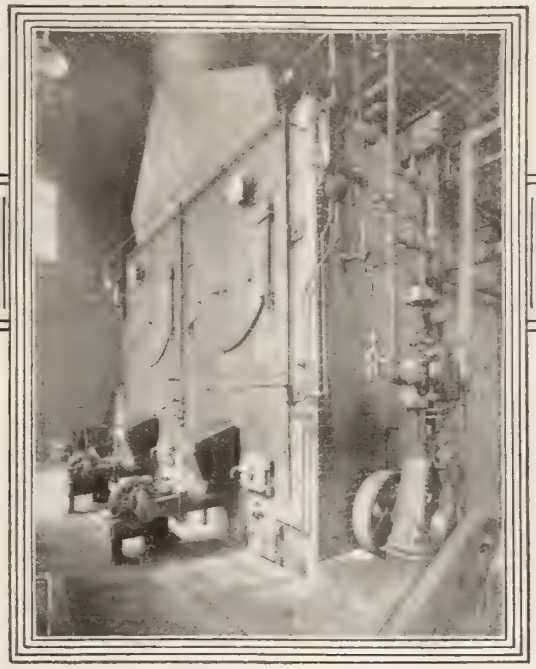
The Garlock Packing Company
HAMILTON, ONT.

Branch Offices :

Montreal, Que. Toronto, Ont. Winnipeg, Man. Calgary, Alta. St. John, N.B. Vancouver, B.C.

Detroit Single Retort Stokers Save Money





The Detroit Single Retort Underfeed Stoker has demonstrated in actual practice that its installation results in the following economies.

1. Fuel Saving: Saves ten to twenty per cent of coal—a result due to more nearly complete combustion. Hand fired plants average fifty to fifty-five per cent overall boiler efficiency, whereas Detroit Stoker fired boilers average seventy to seventy-five per cent and over.

2. Labor Saving: Saves approximately fifty per cent of boiler room labor, depending upon plant conditions.

3. Cheaper Coal: Burns lower grades of fuel than is possible with hand firing. Savings thus effected may be of such magnitude as to pay for the cost of the Stokers each year.

4. Increases Boiler Capacity: Detroit Stoker fired boilers may be continuously driven to much higher ratings than hand fired boilers. This assures an adequate supply of steam at all times. It may permit shutting down one or more boilers, or, where demands are heavy, obviate the necessity of buying additional boilers.

5. Smokeless Operation: With Detroit Stokers smokeless operation at all loads is secured through practically complete combustion.

6. Eliminates Human Factor: Man's efforts constantly vary in intensity and skill. A fireman doing first class work in the morning will be less attentive in the afternoon when he is tired. His efficiency moves up and down from hour to hour and from day to day. Presently he leaves the plant and a new man takes his place. Contrast this condition with one where Detroit Stokers are employed. Steady even production follows as a matter of course. Steam pressure remains constant—the same amount of coal produces the same amount of steam week in and week out—boiler efficiency is uniform.

7. Meets Emergencies: Suddenly varying loads on boilers of medium size, particularly where the number of steam generators in a plant is limited, offer a real firing problem. Hand firing, because of its slowness and the uncertainties of the human element, does not offer a satisfactory solution. Rapid production of steam to meet heavy requirements call for an Underfeed Stoker of the Detroit Single Retort type—a machine especially built for this service.

On every score your boilers should be equipped with Detroit Stokers. Remember, there is a type for every purpose—V-Type Overfeed for natural draft—Single Retort Underfeed for forced draft with boilers developing up to 300-400 H. P.—Multiple Retort Underfeed for large boilers.

Ask for Bulletin 238

DETROIT STOKER COMPANY

Underfeed Forced Draft and Overfeed Natural Draft Stokers

338 GENERAL MOTORS BLDG. DETROIT, MICHIGAN

DETROIT UNDERFEED STOKERS

BUILT FOR BIG BUSINESS

LINDE

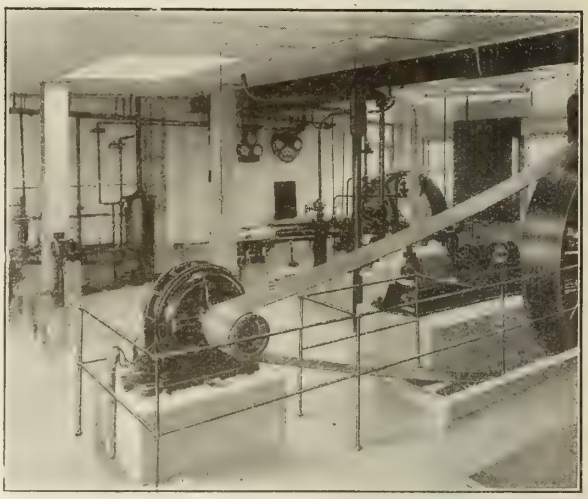
Made in Canada

REFRIGERATING AND
ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

R. PERCY SIMS, LIMITED

Consulting Refrigerating Engineers

358 Beaver Hall Square, MONTREAL, Canada

CANADIAN PLANET ENGINEERING COMPANY LIMITED

WINDSOR ONTARIO

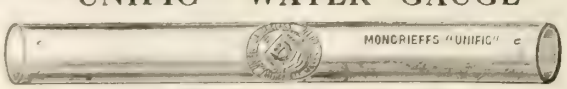
Manufacturers of

PLANET MECHANICAL SOOT BLOWERS

Dealers in power plant specialties, mechanical and hand-fired stokers, valves, steam and vacuum traps, gauges and recording instruments, refrigerating machinery.

MONCRIEFF'S

"UNIFIC" WATER GAUGE



GLASSES

The "Unific" does not readily corrode It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St.,MONTREAL, CANADA

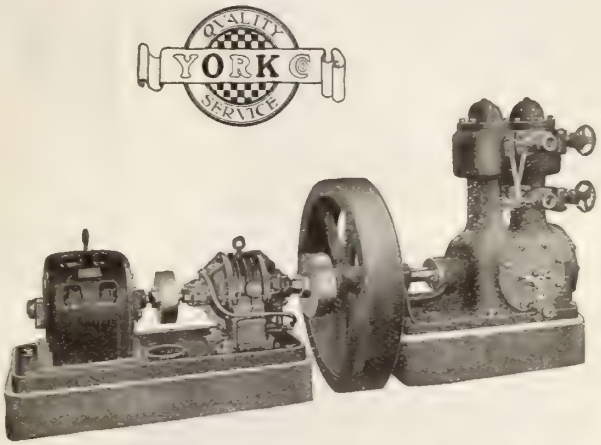
Mechanical Refrigeration is now a Recognized Necessity

More than six hundred hospitals, colleges and institutions of various kinds throughout Canada have realized the necessity of mechanical refrigeration and have installed the YORK system.

The capacities of these machines range from ¼-ton refrigerating duty upwards. Our engineers are at the service of any one contemplating the purchase of an ice making or refrigerating plant to advise them upon the size best suited to their requirements.

Get in touch with our nearest office today.

No obligation whatever.

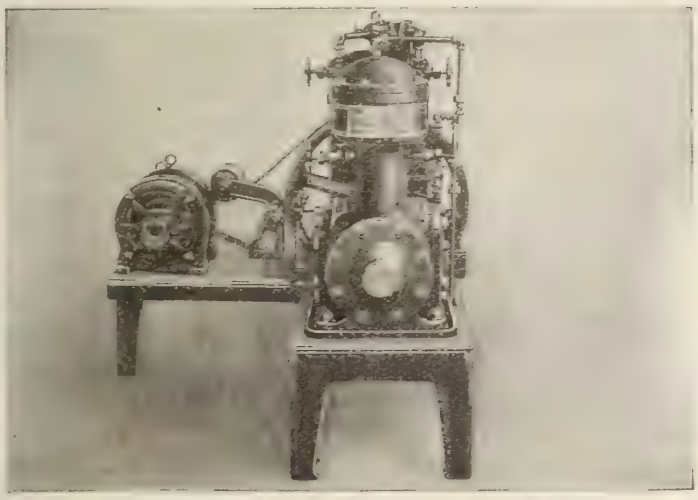


CANADIAN ICE MACHINE CO. LIMITED

Toronto: Villiers and Munition Sts., Eastern Harbor Terminals.
Montreal: 324 Craig St. West. **Winnipeg:** 1415 Whyte Ave.
Vancouver: 1158 Homer St.

York Manufacturing Co., York, Penna., U.S.A.

Ice Making and Refrigerating Machinery Exclusively



FRICK Combined Refrigerating Machine

This machine fills the needs of dairies, groceries, meat markets, restaurants, hospitals, confectionery and floral shops, etc., for a simple and efficient small refrigerating plant.

The machine is manufactured in one ton and two ton sizes. It is a complete self contained unit, including compressor, condenser, separator, receiver and connections mounted on one solid portable iron base as shown. It is completely assembled in one crate with motor and motor base in separate box, and can be taken through a 26 inch door without uncrating.

No foundation is required. The machine is as easily put in place as the ordinary counter or refrigerator, and as easily removed—an important feature to the user who rents his place of business.

Machine is completely protected with safety devices. Either part automatic or full automatic control is supplied as desired. It is unusually quiet in operation and can be placed in any desirable location.

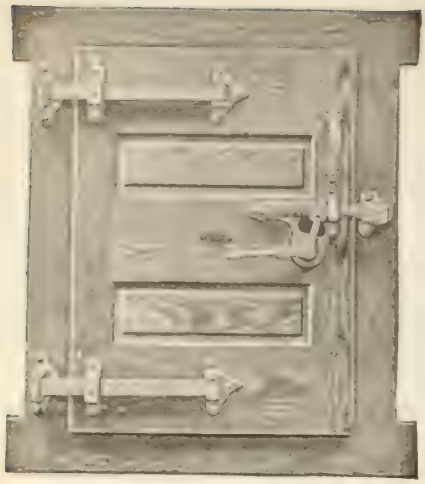
Ask our nearest distributor for further details and prices.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882
BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal



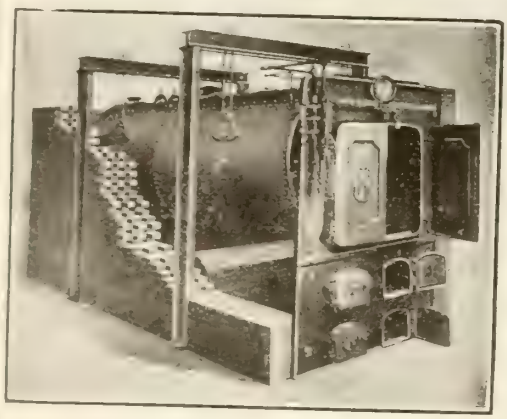
Jamison

HEAVY DUTY
Cold Storage Doors
Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
(Formerly Jones Cold Store Co.)
HAGERSTOWN - MARYLAND, U.S.A.



Return Tubular Boiler with Suspension harness for both ends.

We make the following types of Boilers
CONNELLY WATER TUBE
RETURN TUBULAR
UPRIGHT
LOCOMOTIVE

We specialize in the making of
SMOKE STACKS
TANKS OF ALL TYPES
PLATE WORK OF ANY DESCRIPTION
GREY IRON CASTINGS

E. LEONARD & SONS, Ltd.
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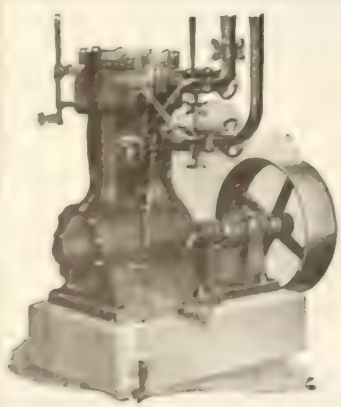
Thos. A. Pippy, Waldegrave St., St. John's, Newfoundland.

ESTABLISHED 1834.

LEONARD



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada
CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company
242 Beecher St. - - - Milwaukee, Wisconsin

Insulated with Nonpareil Corkboard—*one of the general storage rooms of the Commonwealth Ice & Cold Storage Company, South Boston, Mass.*

When You Insulate

When you insulate cold storage rooms you need reliable information on two points:

1. The kind of material that will be most efficient in retarding heat and most durable in service.
2. How to use it, i.e., thickness and method of erection, to insure maximum economy.

Results are what interest you, and results can be satisfactory only when the *best material* is *properly used.*

Nonpareil Corkboard Insulation

For all Cold Storage Rooms

represents the maximum value in cold storage insulation because it combines a competent advisory service with a commodity of established worth—Nonpareil Corkboard. It assures you not only of the most efficient and durable insulating material, but insulation that is correctly designed to meet your particular requirements economically.

Are you building or planning new rooms? Helpful information, literature and samples will be furnished on request. No obligation.

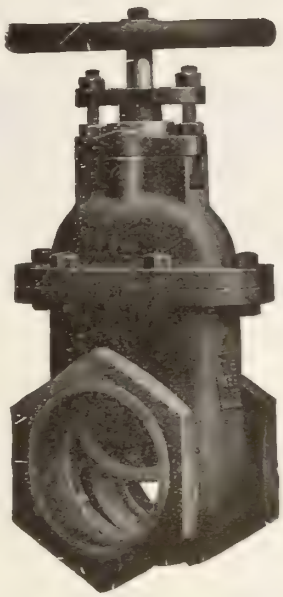
Armstrong Cork & Insulation Co., Ltd.

503 McGill Bldg. **Montreal, Que.**

11 Brant Street **Toronto, Ont.**

Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines, coolers, tanks and cold surfaces generally: Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

KERR



"Guaranteed" Satisfaction

FORTY years' experience has shown us that Satisfactory Valve Service can be attained only by conforming to the most modern and approved practice in both design and construction.

It is this policy, together with the exercise of the greatest care in every detail of the work and the severe tests to which all our goods are subjected, that is behind the KERR Guarantee of Satisfactory Service—a guarantee that backs every sale of KERR Goods.

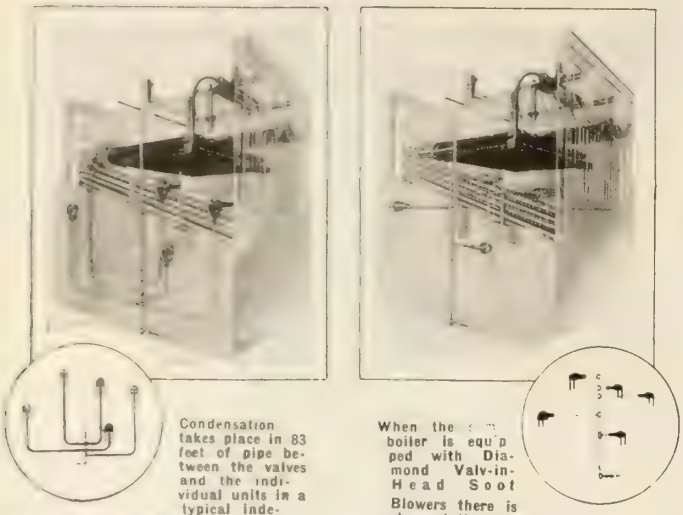
MADE IN CANADA

The Kerr Engine Co., Limited

Valve and Hydrant Manufacturers

WALKERVILLE - ONT.

Diamond Valv-in-Head Soot Blowers Eliminate Condensate and Reduce Blower Maintenance



Condensation takes place in 83 feet of pipe between the valves and the individual units in a typical independent valve soot blower installation.

When the boiler is equipped with Diamond Valv-in-Head Soot Blowers there is beyond the valve no pipe whatever in which condensate may form and be carried over to the blower element.

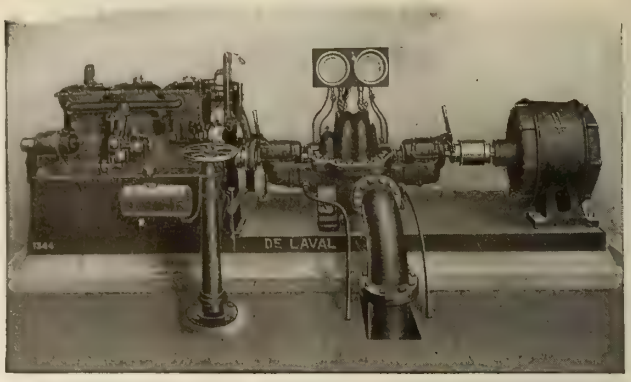
The practical results of the elimination of condensate from the blower element achieved by Diamond Valv-in-Head construction are: increased length of service of boiler tubes; complete removal of soot with no caked deposits left behind; and long life of soot blower elements, with a reduction in annual blower maintenance charges from 25 to 50 per cent.

Elimination of condensate is only one of eleven important advantages of Diamond Valv-in-Head soot blowers. Others include a 50 per cent. saving in labor for operation, and a saving of 50 to 60 per cent. in steam. Remember that Diamond blower elements used in the hot passes of water tube boilers are CALORIZED.

Write for Bulletin 287

Diamond Specialty, Limited
WINDSOR, ONT.

Diamond
VALV-IN-HEAD SOOT BLOWERS



Reliable Water Supply At Low Cost

FOR DRIVING pumps of small and moderate sizes, particularly when placed in remote locations, electric power is often cheapest. Electric distribution systems, however, are subject to interruptions of service, as from storms, power house accidents, etc. A number of users of De Laval pumps, therefore, have insured continuity of service by installing gas or gasoline engines as "stand-bys."

The photograph shows a De Laval two-stage centrifugal pump driven by a Sterling gas engine, as installed at Lindsay, Ont. The pump is designed to deliver 1,325 gal. per min. against 290 ft. head, when running at 1,450 r.p.m.

De Laval centrifugal pumps have been specially designed to give regular, continuous service. All internal parts are accessible upon lifting the casing cover, and can then be lifted out after removing the bearing caps. Parts subject to wear, such as bearings, shaft sleeves, impellers, wearing rings, etc., are made to limit gages and are interchangeable. Repair parts can be obtained by giving the number which is stamped upon each part.

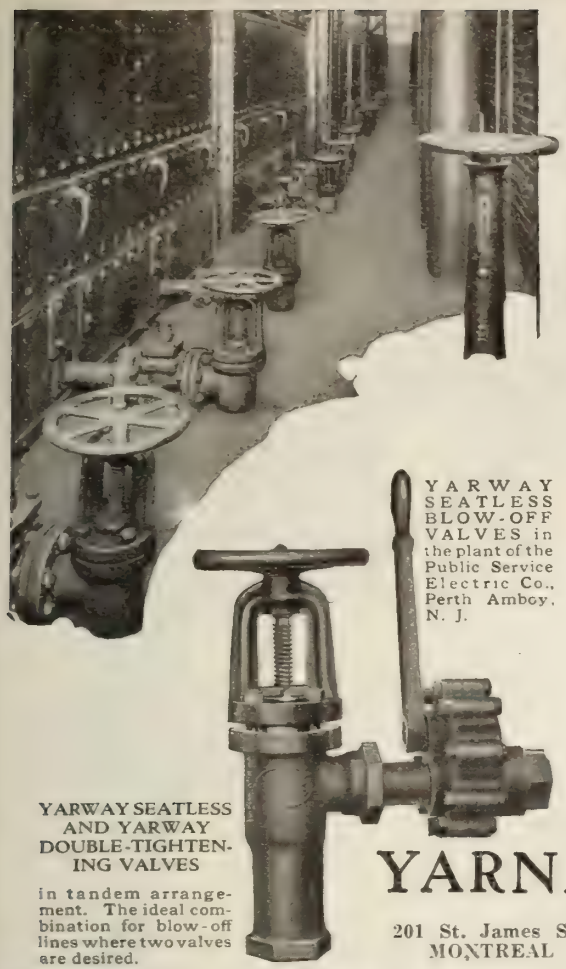
Their high efficiency and low starting torque are peculiarly valuable where electric power is used. All De Laval pumps are guaranteed as to efficiency, and the efficiency is demonstrated by test before the pump leaves the works.

Describe your requirements and ask for our special Catalog B100

De Laval
Steam Turbine Co.

Turbine Equipment Co., Ltd., 73 King St. West, Toronto.
The E. Laurie Company, 243 Bleury St., Montreal, Que.
Taylor Engineering Co., Ltd., Vancouver.

192C



YARWAY SEATLESS BLOW-OFF VALVES in the plant of the Public Service Electric Co., Perth Amboy, N. J.

YARWAY SEATLESS AND YARWAY DOUBLE-TIGHTENING VALVES in tandem arrangement. The ideal combination for blow-off lines where two valves are desired.

Just Valves, or BLOW-OFF *Valves?*

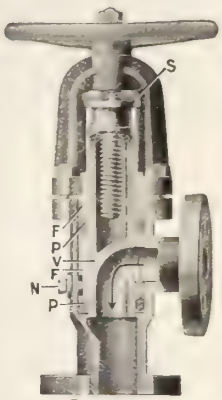
A LIMOUSINE makes an excellent passenger car, but it isn't much good as a truck. A freight car makes a poor Pullman.

It's the same with valves. A valve may give excellent service in one part of the boiler room, but move it somewhere else and it's worse than useless.

Except under very favorable conditions, an ordinary gate valve is totally unfitted for blow-off service. It wasn't made to withstand the destructive action of mud, grit and sediment under high pressure—and it can't. The seat soon becomes scored and worn, and this ordinary valve begins to leak away valuable fuel.

That's why it pays to equip your boiler with a plunger type valve—the YARWAY SEATLESS BLOW-OFF VALVE. It's built especially to stand up in blow-off service. It has no seat to leak; therefore it stays tight, keeps the water and steam where they belong, and saves fuel.

"The Solution of the Worst Boiler Room Problem" tells why this valve is best fitted for blow-off service, and also describes the YARWAY DOUBLE-TIGHTENING VALVE, frequently used in tandem with the Yarway Seatless. We'll gladly forward a copy at your request.



Operation

After valve has closed, shoulder S on plunger V engages the loose follower gland F. A hard turn of handwheel then compresses packing P above and below the port, making an absolutely tight valve. Set-screw N prevents turning of gland when handwheel is turned.

YARNALL-WARING COMPANY

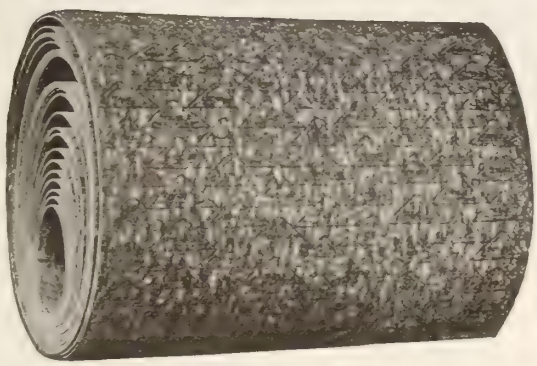
201 St. James St., MONTREAL

Mermaid Ave. and Ardleigh St., PHILADELPHIA

400 Penobscott Bldg., DETROIT

The One Standard Gasket Material

Absolutely unaffected by changes in temperature, Durabla Asbestos Sheet Packing is ideal for every use because it is guaranteed to give satisfactory service under the most severe conditions. Durabla is not affected by superheat, oil, ammonia, gasoline, acids or contraction, expansion, condensation or vibration. Sold on a service basis. Write for trial order.



DURABLA

TRADE MARK REGISTERED

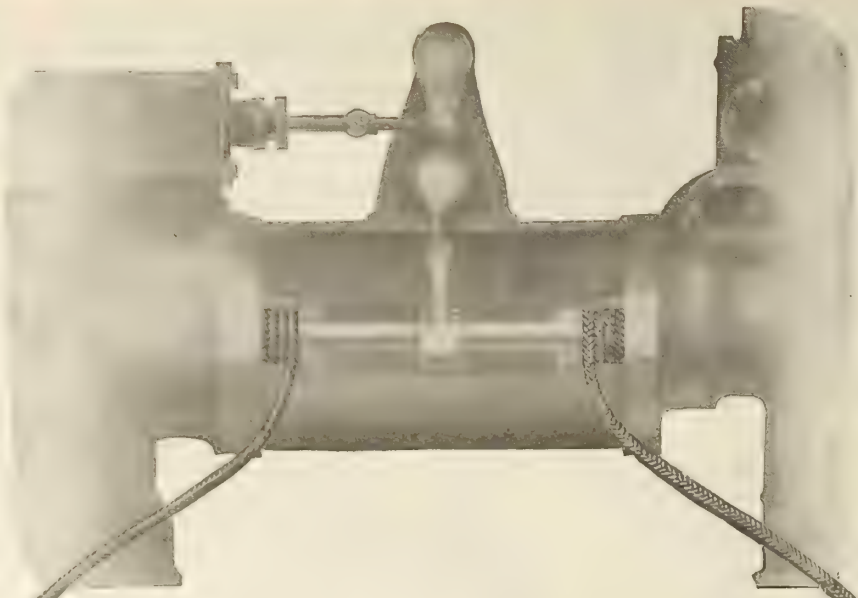
DURABLA MANUFACTURING COMPANY, New York

Distributors for Canada

THE CANADIAN FAIRBANKS-MORSE CO., LIMITED

Canada's Departmental House for Mechanical Goods

DURABLA



Packings for Two Services Both Equally Good

For
STEAM AND COMPRESSED AIR
there is no packing to equal

"PALMETTO"

because the materials of which it is made, as well as the lubricant carried in each single strand, give it a length of service that means real economy.

"Palmetto" is heat resisting, and does not harden in service. It is therefore especially adapted to high speed engines working under high pressure, superheated steam, the very place where most packings fall down.

For
HYDRAULIC PRESSURES
use

SQUARE
PALCO
PLAITED PACKING

made of high tensile strength cotton yarn, carrying a graphite grease lubricant in each single strand.
"Palco" will not swell and bind the piston as to cause the pump to short stroke.
The lubricant which "Palco" carries reduces friction to a minimum, and enhances the life of the packing.
"Palco" is superior to square flax packing.

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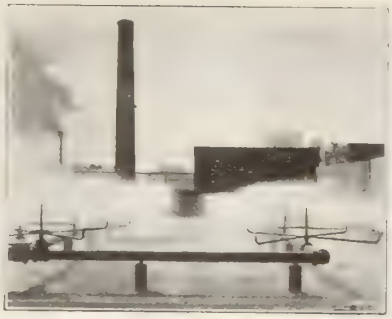

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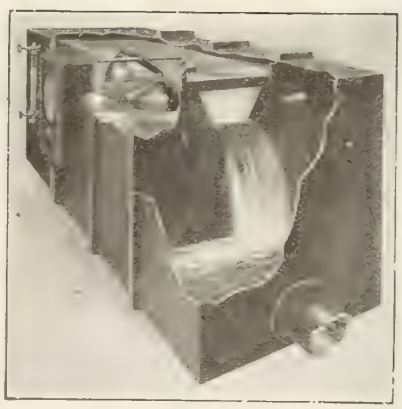

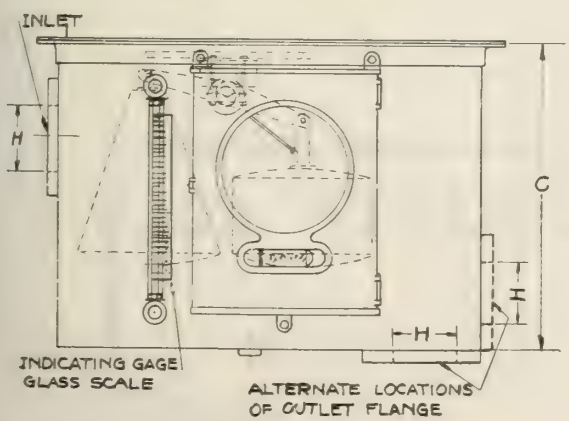

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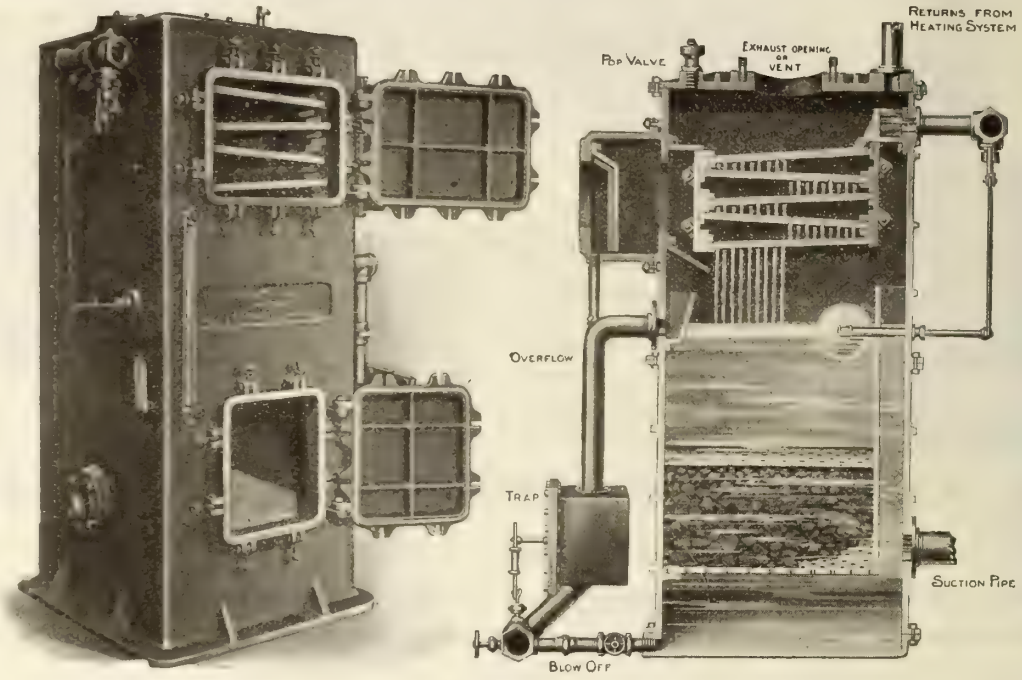

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The Power Plant Journal of Canada

Published in Toronto

Established 1907
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Combustion for the Boiler Room Operator

The Amount of Oxygen Necessary to Burn One Pound of Coal—How This Oxygen is Carried in With the Air—Draft, and Its Measurement in Inches of Water

By T. H. FENNER

BEFORE starting on a discussion of the processes of combustion, let us assure those who are not familiar with it, that there is nothing to be alarmed about. The chemist has come to the aid of the engineer in explaining certain natural laws in which the engineer is deeply interested, and has placed in his hands a simple means of determining the performance of the furnace which is the beginning of the process of generating power from steam.

We have seen that nature has combined a certain number of different organisms into a solid bulk, which we get back from the earth either as coal, or as a fluid oil. The storing up of these materials occupied many centuries, but they can be won back in much less time, and the heat stored up in them can be released very swiftly, if we go about it the right way. The one thing necessary in order to get the heat out of the fuel is that the carbon and hydrogen, which are the heat-containing constituents, shall be liberated and mixed with a sufficient supply of oxygen to enable them to give up their heat, and be changed into a different combination entirely.

Now this oxygen is around us in plentiful quantity, but unfortunately it does not exist as a separate commodity. It is in combination with another gas, and these two gases form the air we breathe. In order to get the oxygen, we have to use the air, with its content of nitrogen, which is of no use to us. Air is composed of pretty closely 21 parts of oxygen and 79 parts of nitrogen in every 100, and it is the 21 parts of oxygen that are of use to us in the process of combustion. So that we shall be able to get this oxygen to mix with our carbon, and thus get the heat we require, we must find a method of passing a certain amount of air through our fuel. To get the right amount, we must first of all find out what is this correct quantity, and then find a means of introducing it to the fuel in an efficient manner.

It is at this point that the chemist steps in and gives the engineer the needed assistance. He tells us accurately how much oxygen we require per lb. of carbon, and also how much air we must use to get this amount of oxygen. How we are to get the air he leaves to us, that being a strictly mechanical problem. Let us see then, how much oxygen we must use to burn to the utmost advantage a pound of fuel, with its different constituents.

The chemist compares the different elements by means of their "Atomic" weights. Thus the atomic weight of carbon is 12, and that of oxygen 16. Therefore, as the oxygen in the air combines with carbon during the process of combustion in the proportion of two of oxygen to one of carbon, forming what the chemist calls CO_2, or carbon dioxide, the proportion of oxygen to carbon will be as 12 is to 32. Then get for the weight of oxygen required the amount of carbon multiplied by 32 and divided by 12. Suppose the coal we are using contains 78 per cent. carbon, then

$$\text{we will require } \frac{.78 \times 32}{12} = 2.08 \text{ lbs}$$

oxygen for the carbon content.

The hydrogen in the coal combines with the oxygen to form water, the chemical symbol of which is H_2O. The proportion of the weight of H_2 to O is as 2 is to 16, or 1 to 8. Then if the hydrogen content of the coal is 6 per cent., we shall have as the oxygen necessary H x 8, and using the percentage we have .06 x 8 = .48 lbs. oxygen.

The coal itself we shall say contains 5 per cent. oxygen, and therefore this amount will have to be deducted from the amount of oxygen to be supplied. We have then 2.08 lbs. oxygen for the carbon, and .48 lbs. for the hydrogen which gives 2.56 lbs. Deducting .05 for oxygen contained in the coal we get 2.51 lbs. oxygen required for the one lb. of coal.

Now we have said that the air contains 21 per cent. oxygen and 79 per cent. nitrogen. We shall therefore have only 21 per cent. of oxygen in each lb. of air, so to obtain one lb. of oxygen we shall require 100/21 lbs. air. Then we shall need for our one lb. of fuel

$$\frac{2.51 \times 100}{21} = \frac{251}{21} = 11.9 \text{ lbs air.}$$

We might say 12 lbs. air are required for one lb. of coal. The amount of air required per pound of coal will naturally fluctuate with the chemical constituents of the coal, but this is taken as the theoretical amount of air that is required.

We shall find that in actual practice we must have more than this amount, but that the closer we can keep the air used to the theoretical amount, the better results we shall get. This will be demonstrated later.

Procuring the Air

We have thus far noted the constituents of the fuel that we use, and its heat value. We have also seen that in order to obtain the heat we must supply a certain amount of air. That brings us naturally to the means of supplying the air in the proper quantity, and the first thing we have to consider in this respect is "draft."

What we call draft is a difference of pressure between the air in one part of a structure and another part, which causes a flow of air from the high pressure region to the low pressure. The difference is usually but a slight one, and may be created by either natural or artificial causes. The best examples of natural draft that we have are the winds, which vary in magnitude and direction from day to day and hour to hour in some places and in others blow steadily in one direction for a considerable length of time and then reverse the direction, and blow just as steadily for a corresponding length of time. These latter winds are known as "trade winds" or "monsoons." Without going into any prolonged explanation, we may say that these winds are caused by a long season of hot weather, which causes a lessening of the density of the air over a large area, with a corresponding lowering of pressure. In order to equalize this the air moves from a region of higher pressure, and thus maintains a steady air current until the gap is filled.

We have exactly the same thing occurring in the furnace and chimney of a boiler. As soon as a fire is lighted in the furnace, the air is heated, and expands. This naturally lowers its density, or pressure, and an inequality of pressure is established between the furnace and the outside air, the air in the furnace being at less than atmospheric pressure. The result is that the outside air pours in, trying to restore the balance. In so doing, a fresh supply of air is given to the fuel, and combustion continues, constantly heating the air, while the outside air is constantly trying to maintain equilibrium, and thus we have the familiar phenomenon o draft.

This is of course just a general explanation. We must know a little more of the subject to understand it intelligently. Fortunately, we can do this without going into any very complicated figures, although we must use some of them. The density of the air varies with its absolute temperature, in a definite ratio which has been determined by scientists to be 1/492 increase of volume for every one degree of temperature added, on the Fahrenheit scale. If the Centrigrade scale is used, there is an increase of 1273 volume for each degree added.

Now we see that the density varies with the absolute temperature, but we want some means of finding just how it varies. We therefore take the absolute temperature of air at freezing point Fahrenheit, which is 32 plus 460, or 492 as a standard. By dividing the absolute temperature at any other point on the scale into this figure, and multiplying the result by a factor for the specific heat, we get the density. Thus suppose we have air at 60 degrees, then the density at that temperature will be

$$\frac{460 + 32}{460 + 60} \times .0807 = .076$$

which works out to .076.

Suppose the air in the chimney were at 600 degrees then its absolute temperature would be 1.060. Dividing this into 492 and multiplying by .084 which is the factor at this temperature we get .038.

These factors for specific heat have been determined by experiment, and we just accept them as being correct. They will vary slightly, but the temperatures for atmospheric air and chimney gases are so nearly constant that these factors can be used in practically all cases.

We usually measure the force of draft in inches of water, and this is arrived at in this way. The pressure of the atmosphere is 14.7 lbs. per square inch, and this pressure is sufficient to balance a column of water 33.8 feet high. Then each pound pressure is equal to a height

$$\frac{33.86}{14.7} = 2.304$$

Then we have from this the fact that a column of water 2.304 feet high will give a pressure of one lb. per square inch on its base, and that the pressure per square inch is equal to the height x .434. Now for convenience we can reduce these terms to inches and ounces.

2.304 feet x 12=27.648 inches. Dividing this by 16, the number of ounces in 1 lb., we have

$$\frac{27.648}{16} = 1.728 \text{ inches}$$

That is 1.728 inches equal 1 ounce pressure, or 1 inch water column is equal to .57 ounces pressure. It is fairly safe to reckon ½ ounce of pressure per one inch water column in ordinary boiler-room work.

We can now bring into use a formula derived by Professor Rankine, to whom the engineering world owes quite a debt. This formula will give us the force of draught for any height and any difference in density of the gases. Let F equal the force in inches of water
D equal the density of atmosphere
d equal the density of flue gas
h equal the height of the chimney
Then F=.192h (D—d)

The factor .192 is used to convert pressure per square foot into inches of water. One ounce per square inch is equal to 144 ounces per square foot, and the height of water column corresponding to this pressure is 1.728 inches. As density is always reckoned in pounds per cubic foot, then the head or pressure must be reckoned in pounds per square foot, so instead of 144 ounces we say 9 lbs. per square foot. If we divide this 9 into the height of the water column we get the height of water column for a pressure of 1 lb. per square foot, which is .192.

To apply the formula, let us suppose that we have a chimney 150 feet high, and that the temperature of the atmosphere in the boiler room is 70 degrees, while the flue gases are leaving the boiler at 650 degrees. We wish to ascertain the force of the draught. First we must find the density of the two different gases. First the atmosphere, which will be

$$\frac{460+32}{460+70} \times .0807 = .074$$

Then the flue gases,

$$\frac{460 \times 32}{460+650} \times .084 = .037$$

We can now apply the formula

$$F = .192h\ (D-d) = .192 \times 150\ (.074—.037) = 28.8 \times .037 = 1.0656$$

That is the draught would be equal to a column of water just over 1 inch high, corresponding to a pressure of .57 ounces.

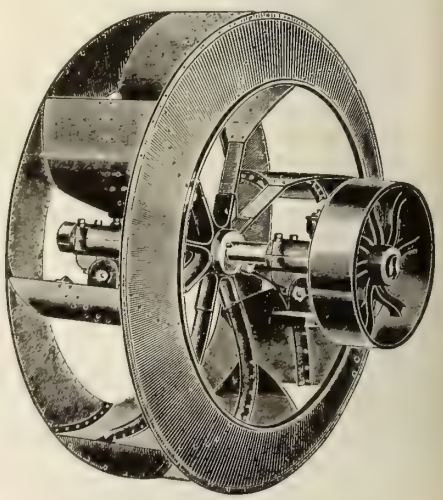
We thus see that with the ordinary chimney draft the intensity of the draft, or in other words, the difference of pressure, depends on the difference in temperature, and the height of the stack.

When we use a fan for draft, we create the difference of pressure by mechanical means, by drawing in air at atmospheric pressure on the suction side of the fan, and compressing it, discharging it into the ashpit or tuyeres of the furnace under higher than atmospheric pressure. The air above the fire being at atmospheric pressure or slightly below it, we have thus a considerable difference of pressure above that which can be obtained by natural draft, and we further have an apparatus which can be regulated to give any desired difference within reason. As the chimney is not required to assist in producing draft, a much shorter stack can be used, thus reducing the cost of this part of the construction.

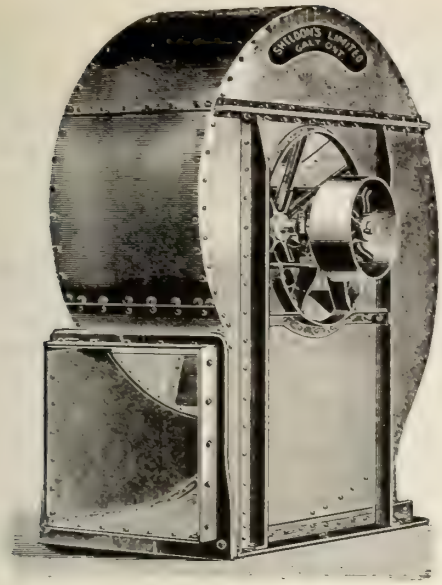
There is a third method of producing draft, known as induced draft. In this method either a fan or a special form of stack is used, but instead of the fan being used to create a pressure in the ashpit it is used to reduce the pressure in the setting and breeching. The fan is set in the uptake of the boiler, and draws the gases from the breeching and discharges them into the atmosphere, through a short stack. Owing to the much greater volume of the hot gases, the fan must be of much larger size than the forced draft fan, and provision must be made for by-passing the gases around the fan and to the stack direct, at such times as the fan may not be working.

With the special form of smoke stack, known as the Evase method, the stack is formed with a tapering throat of the Venturi type, and an air jet is blown through this in the same manner as steam is blown through the orifice of an injector, and with the same result.

Whichever method is used, the object is the same, and that is to get sufficient oxygen to mix with the carbon to complete combustion. The amount of air required will of course vary with the amount of fuel which is being burned per hour, and therefore it is very necessary that some means of regulation should be adopted. In the case of the natural draft produced by a chimney, the regulation is performed by means of a damper in the stack, which closes off a portion of the area, or can be made to completely close it if necessary. Ashpit dampers are also

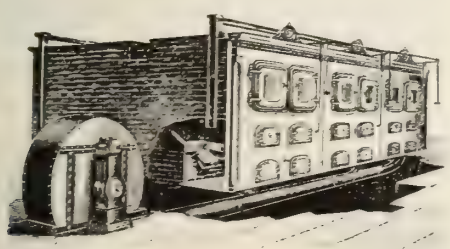


Steel Fan Wheel.



Complete Fan and Casing.

provided, which check the air going into the ashpit, but these dampers would be much better left off altogether. The proper way to check the draft in a natural draught furnace is by the chimney damper. This effectually cuts off the draft, and at the same time tends to equalize the pressure between the furnace and the outside air, thus preventing any infiltration of cold air through the brick work. On the other hand, when the ashpit dampers are closed and the chimney damper left open, the resulting difference of pressure is much greater than normal, and air is drawn in through every crack and crevice of the brickwork, cooling down all the heating surfaces. Another thing that can happen through injudicious use of the dampers is a gas explosion, to the undoing of the brickwork or a portion of it. If the chimney is pretty nearly closed off, and the ashpit dampers are also closed, the process of combustion is halted, and the gases in the furnace become instead of carbon di-oxide, which they should be, only carbon monoxide. This means that the furnace has practically become a gas producer, and the chimney damper being



Forced Draft Arrangement.

nearly closed, the gas does not get away. Pretty soon the steam goes down, and the fireman opens up ashpit and chimney dampers. The result is that the admission of this air to the partially consumed fuel, gives such a quantity of oxygen that the resulting completion of combustion occurs at such a rapid rate that it really becomes explosive in its force. The area of the chimney is not enough to carry away the suddenly increased volume of gas and the result is that the back wall or side walls, are blown out, and everyone wonders what has happened.

This thing occurs very frequently on boilers fired with sawdust and wood refuse, and can happen with either natural or forced draft, and does happen even in plants where such a thing would not be expected.

(To be continued)

LOSSES DUE TO TOO MUCH CARBON MONOXIDE?

By W. F. Schaphorst

This chart gives the fuel loss due to too much carbon monoxide in the flue gases. To determine the loss no figuring is necessary. Just zigzag a straightedge across the chart three times as indicated by the dotted lines and column G immediately gives the per cent. of fuel loss.

For example, a given coal contains 70 per cent. of carbon; the fuel gas contains 10% carbon dioxide (CO^2) and 1% carbon monoxide (CO); the heat value of the coal is 12,000 B. t. u. per pound. What is the fuel loss?

Run a line through the 70 (column A) and the sum of CO^2 plus CO (column B) and locate the intersection with column C. From that located point run through the 1 (Column D) and locate the intersection in column E. From that point run through the 12,000 (column F) and the intersection with column G shows the answer—5.4 per cent. The operation is the height of simplicity for the line is carried directly across from left to right; there is nothing confusing about it.

The range of the chart is wide enough to take care of nearly every condition of flue gases. Should the intersection with column C or E fall "outside of the chart" it will make no difference. Merely extend the line C or E, whichever it may happen to be, and go ahead with the problem.

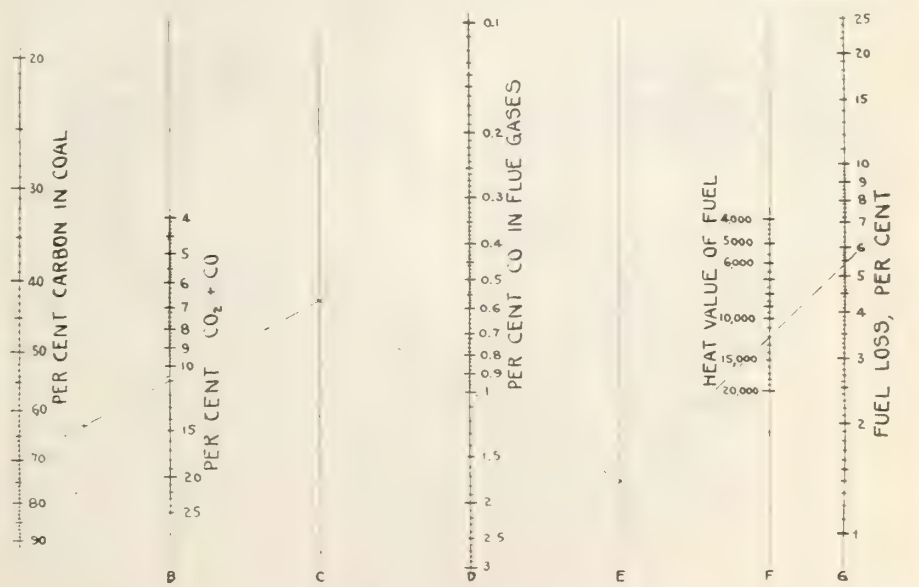
A little study given to the chart, coupled with a few examples of your own making, will soon show why the percentage of CO should be as low as possible and why the CO^2 should be high.

If it is desired to compute the percentage of fuel loss without using the chart it may be done in this way: Divide the percentage of carbon in the coal by the percentage of CO^2 plus CO; multiply by the percentage of CO; divide by the heat value of the coal per pound; and multiply by 10,150. The answer will be the same as given by the chart. The chart, of course, is much quicker.

ELECTRICAL BOILER

The Chicago Tribune, owns a paper mill at Thorold, and recently issued the following statement relative adoption of electricity for steam purposes:

"Arrangements have been completed to make steam in the 5,000 horsepower boilers of The Chicago Tribune's paper mill at Thorold by electricity. Motors in the mill are already operated from this source. Only steam for cooking sulphite and drying of paper on machines has been made from coal. The cost of the change over is less than $10,000, and can be completed in a fortnight. Already the mills of the Laurentide Paper Company, the Belgo-Canadian Paper Company, and the new mill of the International Paper Company, all located on the St. Maurice River near Quebec, have adopted electric furnaces. Electrical fuel competes with coal in making steam, according to the cost of two commodities at the point of use. It takes approximately one horsepower of electricity per year to furnish the heat given by one ton of good Pennsylvania bituminous coal."



Fuel Loss Chart.

Principles of Design of Air Compressors

The Influence of Different Types of Valves—Relation of Clearance Volume to Cylinder Volume—The Question of Efficient Cooling—Single and Multiple Stage Compression

By WILLIAM REAVELL
Before The Institute of Mechanical Engineers.

THE title of this paper obviously covers a very wide field, for any machine which aspires air—at whatever absolute pressure—and compresses it, would be comprised in such a title. Hence, a vacuum pump is an air-compressor, aspiring rarefied air which it compresses subsequently and delivers to the atmosphere. The title consequently covers all vacuum pumps and exhausters; and includes blowers, which are designed to elevate the air to slightly superior pressure, while, on the other hand, it embraces machines having several stages or cylinders, which ultimately deliver the air at extremely high pressure.

A machine which has to raise the pressure of air can be of the reciprocating piston type, or of the rotary type, including turbo-compressors, which Professor Rateau described in a paper at the Civil Engineering Congress in London in 1907, and which have been made in increasing numbers and sizes since then. At that congress the author dealt with reciprocating air compressors in a paper setting out those features necessary to ensure high efficiency in such machines.

In the present paper the author proposes to cover a wider field, and to deal with the features of different types of compressors which are required in each case to ensure that the most efficient results are secured.

The ordinary compressor or vacuum pump for normal use consists of a cylinder and piston actuated by a crank and connecting rod or other forms of mechanism, and containing inlet and outlet valves for the admission and egress of air.

Figs. 1 and 2 show such a cylinder of the double-acting type, Fig. 1 being fitted with "mushroom"-type suction valves and "thimble"-type delivery valves, and Fig. 2 having plate valves. Fig. 1 gives the lesser clearance, but Fig. 2 the better cooling.

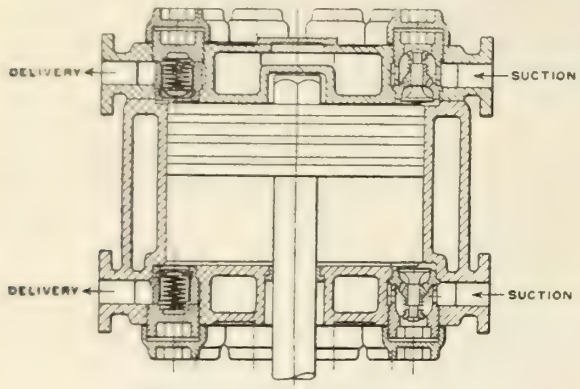


Fig. 1.

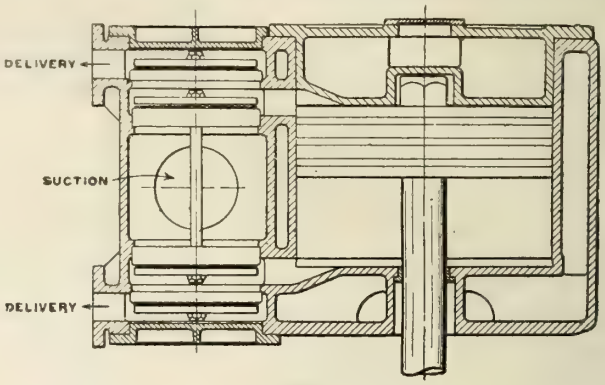


Fig. 2.

A careful designer would have before him the following considerations: (a) Clearance; (b) type of valve selected; (c) provision for cooling; and (d) form of piston-ring.

(a) Clearance.—The relation which the clearance volume bears to the cylinder volume, together with freedom from leakage in the piston-rings, is, neglecting temperature and valve resistance, the two factors which determine the ratio of the volume of free air delivered to the volume swept by the piston. The clearance volume is affected not only by the allowance made between the end of the cylinder and the piston, but by the space required for the valve pockets. The reduction of clearance to a minimum is not essential from the point of view of obtaining the lowest horse-power per cubic foot (or metre) of air delivered where the machines are fitted with automatic — that is, spring-loaded—inlet valves. A designer might elect, for other reasons, to have a larger amount of clearance than the minimum possible, but this is done at the expense of increasing the diameter of the cylinder; the greater the clearance, the longer will be the return travel of the piston on the suction stroke before the air which in the previous stroke has been compressed into that clearance has expanded back again to just below atmospheric pressure to allow the suction valves to open. Obviously, therefore, with an increased diameter of

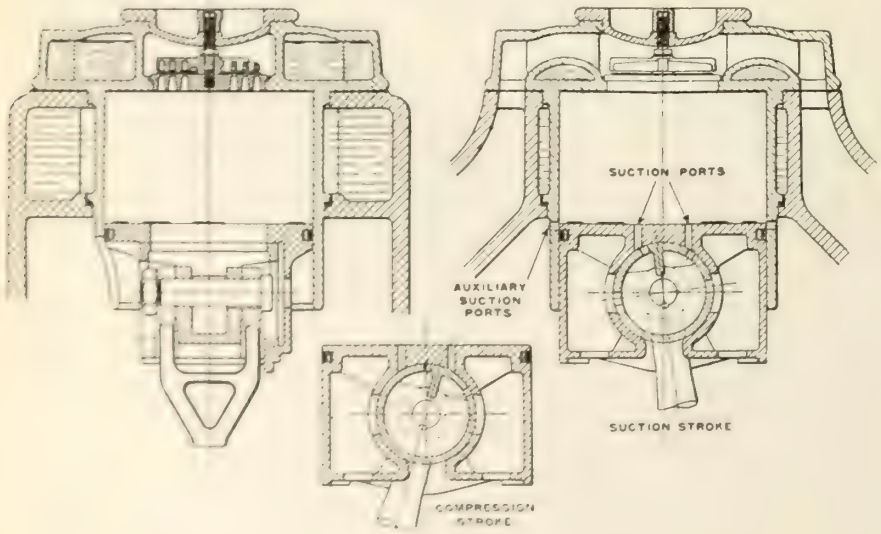


Fig. 3.

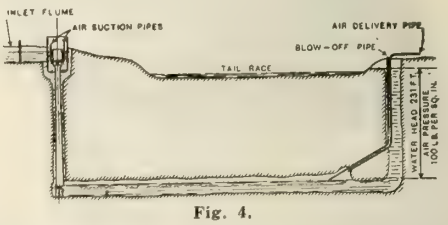


Fig. 4.

cylinder, the same volume can be drawn into the large cylinder as would be obtained in the smaller-cylinder with the minimum clearance.

With all spring-loaded suction valves there must be a slight reduction in the absolute pressure of air aspired, due to the fact that the atmospheric pressure has to overcome the resistance of the spring on the suction valve; consequently, in machines fitted with positively operated suction valves—for example, a piston-valve—or with ports in the piston and gudgeon or "top end" of the connecting-rod (as in the author's quadruplex compressor, a cylinder of which is shown in Fig. 3, the maximum ratio of volume of delivered air compared with the volume swept by the piston can be obtained.

free to open and close over the openings in the cover of the cylinder. The spring of the material was relied upon for the closing of the valve, but a guard-plate was fitted to limit the lift of the reeds.

The Rogler-Hoerbiger plate valve has a multiple-ported plate, which itself is provided with a flexible centre. In this construction the centre to the flexible plate is fixed, thus definitely guiding the plate valve and providing a spring action, although this spring is reinforced with supplementary spiral springs, suitably seated in a guard. In some cases a thin-steel cushion plate is inserted between the plate valve and the guard. In another form of Rogler valve, the valve itself is as described above, but instead of separate spiral springs, the spring valve

driving the machine is reduced to a minimum. Perhaps the only method of air compression which is used to-day in which isothermal compression is obtained is the hydraulic system used at Cobalt, Ontario, and similar installations, where a high vertical fall of water is used to perform the compressing operations. For those not familiar with this arrangement it might be described as follows:—

The water impounded at the top of the fall passes down a vertical pipe, and at the bottom flows into a chamber having a roof higher than the outlet of the pipe. Imprisoned air carried down by the water column is liberated in the underground chamber, and its pressure becomes that due to the head of water in the pipe.

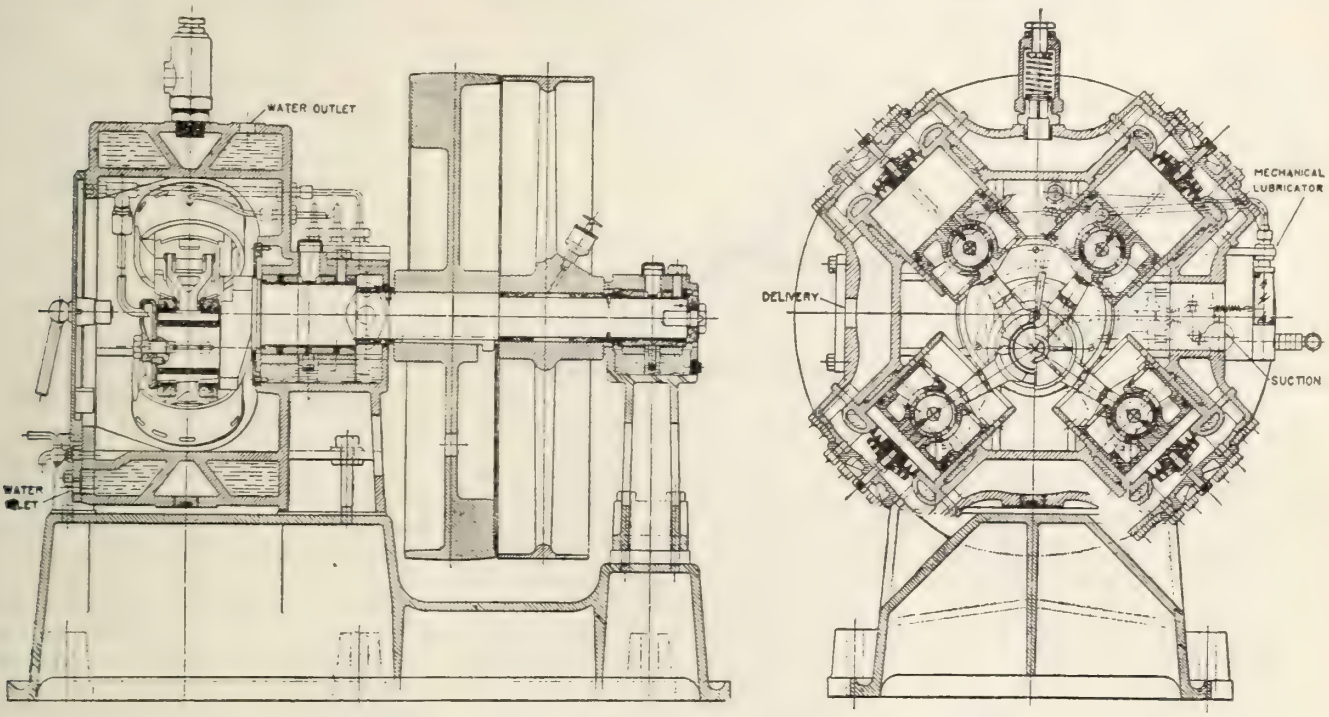


Fig. 5.

(b) Types of Valves.—In recent years the use of plate valves of various forms has become common. In their design and in the choice of materials used, it is important to provide that the construction and lift shall be such that the valves will not crack or break on the one hand, and on the other that they will not deform so as to cause leakage of pressure air during operation.

An early form of plate valve was that introduced by Mr. Mathewson in 1895, in which a disc-plate was controlled by a form of curved flat spring, as commonly used in electric-bell pushes, but having three points at equal distance apart, giving three-point pressure on the plate valve. This was one of the earliest types to avoid the use of separate coil springs.

Valves of the reed type, as used in motor-horns, were made at or before this date by Mr. Peter Brotherhood, a common arrangement being to arrange several reeds in a form of a star, the inner ends of the reeds being secured at the centre, and the projecting ends being

plate itself is reinforced by a strong stop plate, having four curved spring arms, giving four points where the spring pressure is applied to the outer rim of the plate valve.

In the Simplate valve a series of concentric thin annular plates, each separately guided by the cover plate are used, each concentric ring being controlled by small spiral springs seated in the cover plate.

Feather valve: This type of plate valve consists of a series of ribbon-steel strips of differing lengths, so as to seat in a circular plate having slotted ports to correspond with the length and width of each ribbon-steel valve. For this construction a valve guard confines the ends of each ribbon plate, but the plate is free to lift in the middle to allow the air to pass in or out. The ends of each ribbon plate are free to slide, and no additional springs are used.

(c) Cooling.—The problem of efficiently cooling a compressor cylinder and head is one which is extremely important, so as to ensure that the power absorbed in

(Fig. 4 shows this diagrammatically). An air-pipe carried through the roof of the underground chamber enables the air to be led away to the surface for use, and the tail-water rises to the lower surface level indicated and flows away.

In mechanically operated compressors, while isothermal compression is the ideal to be aimed at, it cannot be attained. It is well known that the difference between isothermal and adiabatic compression is represented by the indices to the volume in the following formulae:—

Isothermal compression $Pv=C$.

Adiabatic compression $Pv^{1.41}=C$.

It is clear, therefore, that the closer the index of compression approximates to the isothermal, the more efficient will be the machine.

In compressors of the single-stage type, any reduction from adiabatic compression can only be obtained by the abstraction of heat through the cylinder walls and head, except in special cases where water is injected into a cylinder and subsequently drained away from the discharged air. Consequently, the amount

of heat which can be abstracted depends :—

1. The diameter of the cylinder.
2. Piston speed (in other words, the "time" element).
3. Whether the construction is single or double acting.
4. The thickness of the cylinder walls and head.
5. The amount of the cylinder-head area which can be cooled.

A construction which would be rejected in steam-engine practice—because of the condensation which would be obtained—would, other things being equal, be an ideal contruction for an air compressor, from the point of view of efficient cooling. In large double-acting compressors, with a high piston speed and the thick cylinder walls demanded, very little reduction from adiabatic compression can be obtained.

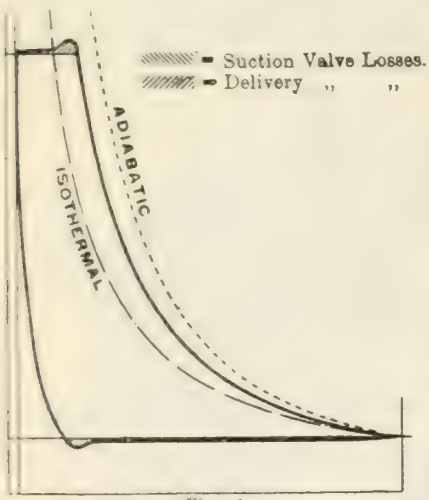


Fig. 6.

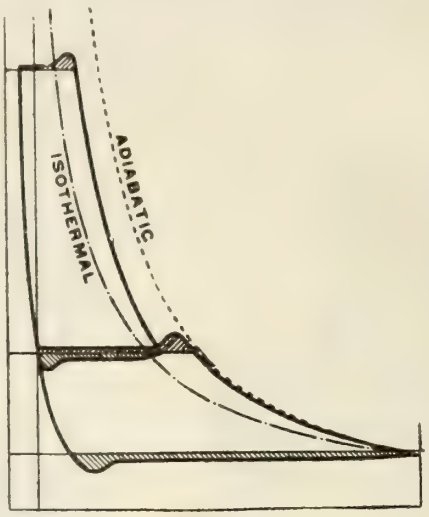


Fig. 7.

In compressors of the single-acting variety, having one idle stroke per revolution, so far as work done upon the air is concerned, the cooling will be better in multi-cylinder machines than in single-cylinder machines of the same total capacity. Where thin inserted liners are used for cylinders, the metal can be thinner than with a cylinder cast integrally with its jacket and flanges; hence, in the author's quadruplex compressor, Fig. 5, where four single-acting cylinders with thin walls are separately attached to a circumferential casing containing the crankshaft, and where moderate piston speeds are used, the cooling effect is probably the maximum obtainable in modern single-stage machines for 80 lb. to 100 lb. delivery pressure, and the index of compression is of the order of 1.23, or nearly half way between isothermal and adiabatic compression.

When compressing air in stages to higher pressures, this question of cooling has a definite bearing on the degree of compression which can be economically obtained while still retaining the simplicity of single-stage compression. In considering a two-stage compressor the author would point out that adiabatic [illegible] double-acting machines entails using two-stage cylinders for pressures for which that construction is not necessary when the cooling conditions are more ideal.

Fig. 6 shows a typical indicator card from a single-acting machine, the compression curve being constructed to the formula: $P v^{1.23} = C$. Superimposed on it are dotted curves, assuming isothermal and adiabatic compression.

Fig. 7 shows compression carried out to the same delivery pressure in two stages in a double-acting machine, the air, after the first stage of compression, being cooled in an intercooler almost to the initial temperature, and thereby reduced in volume; the compression curve (in both the first and second stage) is assumed as $P v^{1.35}$, as found in practice for high-speed machines of that type. The total area of the diagram is further increased by the fact that the delivery pressure in the first stage is higher than the intercooled pressure; and the suction pressure in the second stage lower than the intercooler pressure—by the resistance of the springs of the valves.

The results show that the total area of the single-stage machine (in full lines, Fig. 6) is less than the combined area of the two-stage diagram, Fig. 7, for the delivery pressure of 100lb. for which the diagrams are made. The closer the diagram Fig. 6 approaches to the isothermal the higher is the permissible delivery pressure for which single-stage compression is justified. Hence, in the single-acting quadruplex compressor, single-stage compression can be used for higher delivery pressures than in double-acting machines of higher piston speed.

Fig. 8 is a graph which shows the actual performance of single-stage machines, and indicates that of two-stage machines of similar capacity deduced from the above data. The pressures at which the curves cross one another will be noted.

(d) Piston-rings.—The airtightness of piston-rings has an obvious bearing on the volumetric efficiency obtained, and also on the horse-power per cubic foot or metre of air delivered. Leakage past the piston-rings being a function of time, tightness of piston-rings is of less relative importance with high piston speeds than with slower speeds, and in multi-stage machines piston-ring leakage, which tends to increase as the pressures become higher in succeeding stages, has the effect of increasing the pressure at the lower stage. Experiments by the author's firm indicate that better results are obtained if piston-rings, accurately machined to the cylinder diameter, can rely for their spring pressure upon a spring ring behind the packing ring (preferably with air packing), than if sprung-over rings of the Ramsbottom type are used.

These experiments also show that, in high-pressure pistons of three-stage machines, when several sets of rings were used, each set of piston-ring and spring ring should be carried in an independent carrier, the whole group being so secured by the junk ring that, while the series of carriers are firmly held, each set of rings has the requisite freedom of movement.

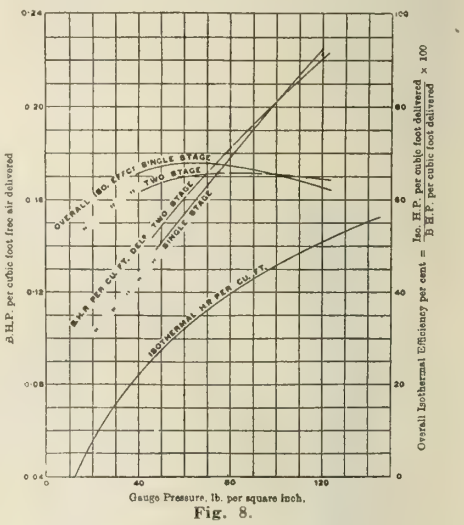


Fig. 8.

Multi-stage Compressors.—The same principles which govern the delivery pressure at which two-stage compression is adopted, apply also to compressors of more than two stages. When extreme pressures are used, the system of packing for the higher stages requires careful consideration. Modern British practice for pressures of 2,000lb. and above usually provides for fibre or similar packing for the final plunger in the form of neck-rings, the plunger or piston itself being without packing rings, and accurately guided.

A notable instance of design for extreme pressures was given in the discussion on a paper by Mr. West at a joint meeting in London of the Institution of Mechanical Engineers and the Society of Chemical Industry, where the super-compressor designed and made by the eminent French scientist, Professor Claude, of Paris, for 1,000 atmospheres pressure, in connection with his synthetic-ammonia process, was described. In the final stage of this machine the ground piston is packed with a hat leather, and cool working is ensured by making the plunger hollow, and supplying it with cooling water—an interesting solution of a difficult problem.

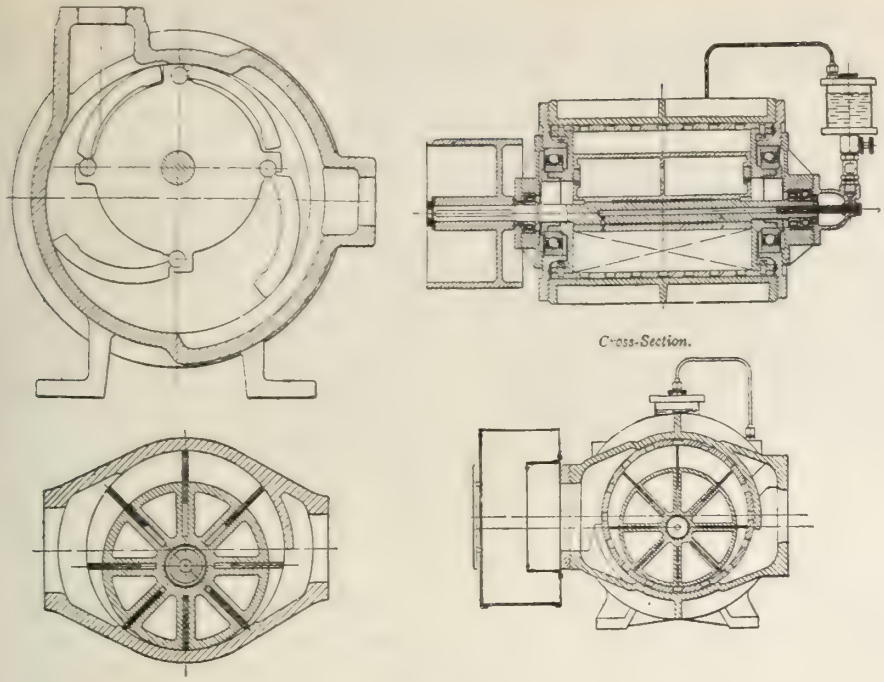


Fig. 9.

In multi-stage machines the practice in the construction of intercoolers has undergone a change, and the copper-coil coolers which were almost universal (and are still used in smaller machines of that type) are being replaced in large industrial compressors by straight-tube intercoolers. Copper coils, however, are still used in the final stages of such machines.

Straight-tube intercoolers should preferably be constructed on the "counter-current" principle, and with the air passing through the tubes while the water surrounds them. Provision must be made for blowing-off the water separated from the compressed air during cooling, and to provide that the air which may be separated out from the cooling water itself cannot form air pockets which might

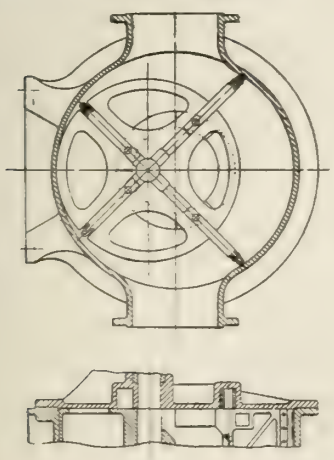


Fig. 10.

impede the free passage of the cooling water.

Rotary Compressors.—Just as, since the days of the Hero engine, the rotary principle has exercised a fascination for inventors, and has led up to the highly efficient steam turbine of to-day, so have succeeding generations of compressor designers endeavoured to apply this principle. Amongst the many forms experimented with, the crescent type is probably the most frequently used. In principle it consists of a rotor, the shaft of which is carried in bearings eccentric with the stator or casing, so that the path of any blade attached to the rotor sweeps a crescent form between the rotor and stator as the rotor revolves. One familiar type uses hinged blades, as in Fig. 9. Another uses sliding blades, as in Fig. 10. In some cases the blade is guided by curved slippers working in a turned groove in each end-cover, as in Fig. 11. This groove is concentric with the stator or casing; the slipper carries a pin attached to the blade, and hence the blade is suitably guided as the rotor rotates, so that the tip of the blade maintains approximate contact with the inside of the stator.

PACKING TROUBLES

By W. F. Schaphorst

In talking to a chief engineer not long ago I showed him a picture of a metallic packing which is giving very good service all over the United States and Canada. A point in its favor is that it need not be removed very often, if at all. An installation was inspected lately, for example, where a plunger equipped with this packing had been in operation for six years, operating against 160 pounds pressure, 212 degrees water, operating 12 hours per day, and the plunger was not so much as worn 1-1000 inch. The packing was still in perfect condition, and looked as though it should last 12 years more. The engineer in charge thought that the packing had saved him considerable time and labor and the owner considerable money. The chief engineer to whom I was talking, however, had his mind already made up, and was not open to conviction. He said, "I have tried metallic packing and will never try it again. It becomes a solid metallic mass, and if used in places that are difficult of access, it cannot be removed easily enough. I have had to chip it out in several instances."

It is regrettable that such chiefs still exist. This man is in charge of a large plant, and his mind should be open to new things. Improvements or attempts at improvements should be looked upon in an unbiased way, regardless of what experience may have taught with other equipment made of the same material. If all engineers had thrown up their hands after the first failure we would not have progressed very far in the manufacturing world by this time. With any packing, whether it be fabric or metallic, there are some cases where inaccessibility in design of stuffing boxes makes the packing very hard to remove. And the engineer's statement with reference to the metallic packing is true to the extent that it is more difficult to remove than the fabric, but it is the claim of this manufacturer that his packing needn't be removed. In other words, if the word of the manufacturer is reliable, as I hope it is, you can leave it in, and removal troubles are eliminated. In case it is necessary to remove certain metallic packings spirally it is not very difficult to screw into the packing itself with packing hooks made for the purpose, and pull the packing out. With separate individual rings, which do not amalgamate with the other rings the removal operation is performed with still greater ease.

So, all in all, the writer is convinced that the above chief engineer is considerably in the wrong. His case is analogous to the engineer who declared he would never install another centrifugal pump because he tried one once, and it wouldn't pump enough water. The pump he had was all right for its capacity, but what the engineer needed was a larger capacity pump. However, the engineer could not see it that way because he had been prejudiced against new fangled equipment from the start, and was determined to go back to the old form reciprocating pump, which was a steam waster, but he could speed it up when he wanted to pump greater volume of water in a given time.

FLEXIBLE PIPE HANGER

Messrs. W. H. Cunningham & Hill, Ltd., Richmond St., W., Toronto, are now putting on the market a flexible pipe hanger. This galvanized band can be easily bent to fit any sized pipe, while the distributors point out that the drive points are hardened so as to be easily driven into the joists. An important feature is the fact that the hanger can be shortened by winding around the pipe, if necessary. Another advantage claimed for the flexible hanger is the fact that one size can be used to take the place of many different sizes previously required.

Montreal Firm Builds Largest Hydraulic Valve in the World

THE rapid strides made in the last ten years in the sizes of water turbine units have naturally called for similar developments in the line of accessory equipment. During the present summer there was installed at Shawinigan Falls, P.Q., a 41,500 h.p. unit, which turbine operates under a head of 145 feet, making 138.5 r.p.m. The last link in the equipment which feeds the water to this turbine is a steel penstock 20 feet in diameter. At the end of this penstock nearest the turbine, is located a Larner-Johnson valve, which is used to shut the water off the turbine, and this valve is the largest of its kind in the world. The valve was designed by the Larner-Johnson Valve and Engineering Co. of Philadelphia, and was built by the Dominion Engineering Works Ltd., of Lachine, P. Q.

Fig. 1 shows the valve assembled in the shop previous to same being shipped. The tapered part of the valve casing, shown to the left in Fig. 1, is made of cast steel, and is composed of four pieces. This section contains the removable seat on which the plunger closes, when it is wished to turn off the water. The first machine operations on this section of the valve casing are to face, drill, spot, and ream the flanges which permit the four pieces to be bolted together to form a circular piece. Fig. 2 shows this work in progress. A large duplex horizontal facing, drilling and boring machine is used. No templates were made for this work. Two of the four pieces were marked off and drilled. Then the four parts were assembled, so that a drilled section was between each section not drilled. Then the locations of the holes in the undrilled sections were obtained by marking same with a scratch awl, using the drilled sections as templates.

As soon as the sections were bolted together work was continued on a large boring mill. The end flanges were faced and the casting bored for the plunger, brass bush, and seat. Some of the principal general dimensions of the valve are: outside diameter of the casing, 23 feet; extreme length, 27 feet; inside diameter of the casing 22½ feet tapering to 13 feet at the outlet. This latter dimension is approximately that of the intake diameter of the turbine scroll casing. The diameter of the cylindrical plunger inside the shell is 16 feet. This plunger has conical ends and can be seen protruding from the casing in Fig. 1. The total weight of the valve is 150 tons and the plunger or moving part weighs 25 tons.

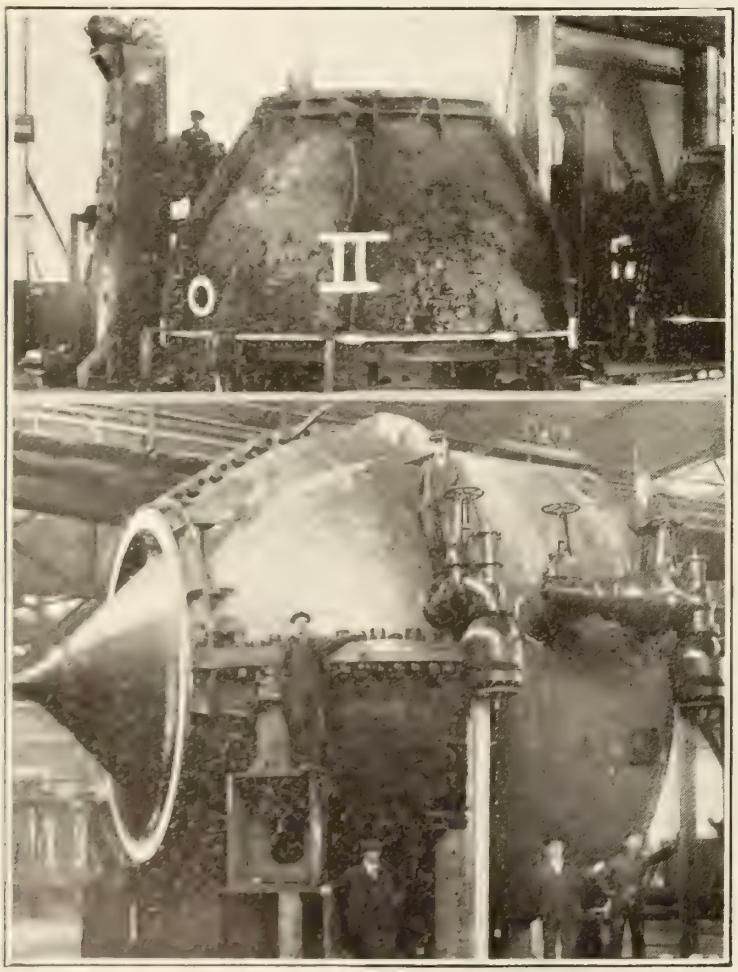


Fig. 1.—Lower: Largest hydraulic valve in the world.
Fig. 2.—Top: Machining the valve castings.

This valve is the largest in the world and is operated by varying the pressure in an annular space, which is located between the casing and the plunger.

That cylindrical section of the valve shown to the right in Fig. 1 is made from heavy steel plate, and rivetted to the cast steel section of the casing. This plate section is rivetted to the 20 foot diameter steel flume. Large brass sleeves line the annular chamber and guide the integral steel rings, (one on the casing, one on the plunger), that seal the ends of the annular space. Thus when the plunger moves, a contact of brass and steel is made.

TORONTO NO. 1 C. A. S. E.

The regular meeting of the Toronto branch of the Canadian Association of Stationary Engineers was held on Tuesday, Aug. 15th, at Cumberland Hall, and despite the uncomfortably hot weather, quite a good turn out of the membership were present. In addition to this, four members were admitted to the branch, and the president, Bro. R. MacLaren, announced that he had the names of a number of engineers who were seeking admittance. After the routine business of the branch had been gone through, which was done in quick order, the meeting was opened for educational purposes. A question which had been deposited in the box, was taken up for discussion. This was, "Does excess air in the furnace raise the temperature of flue gases, and if this is so, why?"

The question was discussed by Bros. Fenner, Soucy, McCarthy, and MacLaren. In this connection it may be mentioned that Bro. McCarthy was one of the new members initiated at that meeting, and he showed the right spirit by rising and joining in the discussion in such a helpful manner. These are the kind of members who are going to lift the C. A. S. E. into the position it should rightfully hold.

It has been decided that the educational sessions will be thrown open to any engineers who wish to take advantage of them, irrespective of whether they belong to the association or not. In this connection it has been decided to give a definite invitation to the local union to join in these educational meetings, so that they may benefit by them.

The educational programme for the session, is again printed in this issue of Power House, and it will be seen that it is an attractive one. With the passing of the summer and the advent of more propitious weather for these kind of meetings, Toronto No. 1 Branch, C. A. S. E. is looking forward to a series of splendid meetings.

The Gennevilliers Central Station

(Continued from August 20th Issue)

Low-tension Switchboard Room

This building, adjoining the preceding on its west side, is also metal framed, but of very light construction, with brick filling, both solid and perforated, and lined with tiles; it is 23 ft. wide and 280 ft. long, enclosing, at a height of 36 ft. above foundations, a gallery 6 ft. 6 in. wide in the lower portion of the building, containing the main transformer switches, and alongside this a span 16 ft. 4 in. wide containing the laboratory and the auxiliary transformers. There are also two other floors at heights of 56 ft. and 69 ft. respectively above foundations; of these, the lower carries the auxiliary 3,000-volt switchboards and the small wiring switches; the upper floor carries the 60,000-volt and also 3,000-volt switchboards, as well as the continuous-current 500-volt board and the three-phase 220-volt board. It also comprises the dispatching gear and the main telephone exchange as well as the air filters arranged at the north end.

Boiler-house

The boiler-house is entirely of reinforced concrete carried on blocks resting on groups of piles. The stanchions, commencing at 109 ft. above foundation level, and the roof principals are the only metal portions of the structure. The boiler-house is 150 ft. wide by 283 ft. long. The roof principals rest on shoes at 160 ft. above foundations, giving 86 ft. of head room in the building.

There are two rows of boilers arranged lengthwise of the building consisting of ten Babcock boilers in pairs with 10 ft. clear way between the pairs, and arranged for firing ultimately with mazout, and the other row consisting of five Stirling boilers. This installation corresponds to the five turbo-alternators to be erected in the power-house; provision has been made for extensions in both the boiler and power-houses. The two rows of boilers are separated by a central gangway 28 ft. wide and at the sides there are gangways 22 ft. wide on the Babcock and 23 ft. on the Stirling side; these are connected by six cross ways each about 10 ft. wide.

A large basement extends under the boiler-house at a height of 33 ft. above foundations, and carries the various railway tracks necessary for removal of clinkers, ash, etc. Above this a floor at 46 ft. above foundations carries the piping, and a third floor at 56 ft. above foundations on the level with the power-house floor forms the actual firing floor. Bins of reinforced concrete are arranged in the ways between the boilers of a size sufficient to contain a total of about 3,800 tons of coal.

This building, arranged to the west of the low-tension switchboard, is constructed entirely of reinforced concrete, the construction consisting of piers and cross members carrying a roof with a slight fall each way. The north and west walls are filled with white brickwork; the south end has a temporary metal end. There is a passage way round the upper part of the building with staircases, and communicating with both the high and low-tension switchboard rooms.

Water Conduits: Intake

This consists of two channels of reinforced concrete 6 ft. 6 in. wide by 14 ft. 6 in. deep separated by a wall 1 ft. thick and both communicating with the common lodge from which the water is drawn.

Return

Under the power-house is a single conduit, 12 ft. 6 in. by 16 ft. 10 in., which is divided on leaving the building into two, measuring 8 ft. 1 in. by 6 ft. 4 in., separated by a wall 1 ft. thick, and arranged obliquely in plan so as to deliver into the river about 450 ft. below the intake. Arrangements are provided for maintaining the water level even in time of drought.

Lodge

The lodge is 92 ft. long by 34 ft. wide, and is arranged with seven inlet channels fitted with screens and strainers for removing dirt and foreign matter from the water; a well sunk below the lodge serves to feed the pumps used for clearing the screens and strainers.

The Quay Wall is built of reinforced concrete with an outer slope of 63 deg., the top being at 34 ft. above foundation level, and is stiffened with reinforced concrete work on the inside. The coal store is arranged 26 ft. 6 in. above foundation level parallel to the river between the main buildings and the river; it measures 650 ft. by 130 ft. It is enclosed by a wall on the side nearest the river and by earth embankments covered with reinforced concrete on the other sides. A traveling gantry transfers the coal to the store. Railway tracks running at the quay level serve for handling wagons.

Plant

The five turbo-alternators are of 40,000 kilowatts each, one being supplied by Escher Wyss (Switzerland), and the others half by the Société Alsacienne de Constructions Mécaniques, and half by Messrs. Schneider and Cie. The steam pressure is 22 kilos. per square centimetre (310 lb. per square inch), and the turbines run at 1,500 revolutions per minute. The alternators have closed-circuit air cooling, with make-up of filtered air; the tension of the terminals is 6.000 volts.

Each turbo-alternator group delivers to three single-phase step-up transformers raising the voltage to 60,000 and connected direct to the high-tension switchboard, where they feed the 60,000-volt bars to which the sub-station feeders are connected.

The particulars of the boilers are:—Working pressure 350 lb. per square inch; temperature of superheated steam, 375 deg. to 400 deg. Cent.; heating surface per boiler, Babcock, 14,000 square feet; Stirling, 22,500 square feet; evaporation per hour, Babcock, 117,000 lb.; Stirling, 176,000 lb; forcing fans and induced draught. The feed water from the condensers is heated to 80 deg. Cent. at the turbine, and further to 100 deg. by the exhaust from the auxiliary machines; then after de-gassing it passes through steel economisers above each boiler, leaving these at about 160 deg. Cen. to enter the boiler. The gases leave the boiler at 340 deg. Cent., and fall to 220 deg. Cent. in passing through the economiser, and then in passing through the air heaters they are further reduced to 150 deg. Cent. The air forced under the grates passes through the heaters, and is raised to about 90 deg. Cent. before entering the fire. The economisers have 13,000 square feet surface for each Stirling boiler and 17,000 square feet for each pair of Babcock boilers. The condensers have 37,000 square feet cooling surface and are supplied by two circulating pumps each capable of delivering 6,750 tons of water per hour (for the whole eight sets, two standing by and six running, this will be equal to 9 tons of water per second).

The level of the yard and works has been arranged to come above the highest flood mark of the Seine.

When fully equipped, the station will have cost a little under 600f. per kilowatt, on the 200,000 kilowatt basis, a figure which will be reduced to 350f. when the output reaches 320,000 kilowatts; this is about the same as the mean figure for installations equipped before the war. The area of power-house per kilowatt is 1.18 square feet, and the area of boiler-house 2.36 feet.

The station is not yet complete, but it has relieved the situation of the supplying companies, which had reached the stage of being unable to supply new demands. The standardising of the three-phase current at 50 periods, which will shortly be effected, will do much to simplify the construction of motors and to reduce the cost to the consumer.

BULLETINS

The Yarnall Waring Co., Philadelphia, have issued a bulletin T-1701 describing "Yarway" steam traps, and this is available to any one interested. The trap is of the bucket type, and possesses several features, which are clearly described and illustrated in the bulletin. A table of prices and dimensions, and one of capacities and weights are also included.

Member of the Audit Bureau of Circulations

POWER HOUSE

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TORONTO, SEPTEMBER 5, 1922

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Dangerous Leanings

WE HAVE before us at this moment a despatch published in the "Vancouver Federationist," of Vancouver, B. C. The despatch in question is a report of a meeting of Local 844, Steam and Operating Engineers, and comments on the fact that this local is making good progress in spite of there being a dual organization in the city. It also states that a visit had been paid to the local by the International President, and that he would soon be returning. All this seems purely legitimate Union business, and whether we are in sympathy with the Union or not, calls for no comment. However, we come to a statement that we think does call for comment in these times, and that is: "A delegate was elected to the Friends of Soviet Russia, and the local will, on receiving his report of that organization's activities, take such steps are are possible to render assistance in a practical manner."

What any sane engineer expects to receive from Sovietism or Bolshevism is more than we can imagine. If there is one man more than another who depends on his own individual ability, and willingness to work and study for success, it is the engineer. We feel that these men who are so willing to extend assistance to Soviet Russia, must have but a very feeble idea of the conditions of things in that unhappy country under Soviet Government. We can understand well that charitable people should be anxious to extend help in the way of food to the children who are starving to death, and whose parents have been murdered by this beneficent Soviet. We cannot understand how any man, living in this free Dominion, should wish to change his state for that of the persecuted and slave driven victims of Lenine's experiment in Communism.

We feel that any man who has Soviet or Communistic leanings is not a good citizen of this country, but is a danger to it. We are not familiar with this particular Union, but it is evidently a United States organization. There are some things imported from our neighbors to the South which we would be much better off without. This is a free country, and men have a greater amount of latitude in what they do or don't do than in many other countries, but we feel that when their activities extend to encouraging Sovietism in any shape or form, they should be curtailed.

An Unsatisfactory Situation

SINCE OUR last issue there have been developments in the coal situation which lighten it to some extent, but it still remains sufficiently serious. The miners in Nova Scotia have voted to return to work, and at the time of writing, great hopes are expressed for a settlement of the anthracite strike. The soft coal mines have been producing steadily if not fully all

The greatest drawback still remains, the railway situation which will have as much effect in limiting the fuel supply as actual stoppage at the mines has had. The United States government blow hot and cold on the question of action, and are at one moment going to step in decisively and control everything, but in the succeeding moment arrive at a decision to refrain from doing anything.

In Ontario the fuel controller takes a very serious view of the situation, while the coal dealers seem to take the attitude that everything will come out all right, and therefore there is no need for drastic action. Between all these different opinions it is hard for the average man to make any definite decision.

Viewing the situation from the information available, we should say that as far as industrial plants are concerned, they will be able to fill their requirements. There will, no doubt, be occasion for economy, but it is our contention that this necessity is always present, only it gets greater attention in a time like this. For the domestic consumer, the prospect is for considerable inconvenience, if not actual hardship. We can hardly blame the dealers for not rushing into the market for Welsh coal, which may possibly be left on their hands. As far as municipalities are concerned, we think that the town and city councils should have made a careful inventory of the coal supplies on hand and the prospects of getting new supplies, and taken action before this time to ensure that the community should not suffer or be held up by profiteering dealers.

It is quite possible that many householders will have to burn soft coal in their furnaces this winter. There is no reason why they should not be able to do so successfully. It will require more looking after than hard coal, and on account of it packing together much closer, will require more draft than it is usual to carry with hard coal. The average house has a chimney quite high enough and of ample area to give this draft. What will be necessary is that all joints in the piping are carefully looked over for leaks, and care taken so that the air will all reach the fuel through the grate bars, except what is necessary to pass over the top for burning the volatile gases.

The engineer and fireman can come to the help of his neighbor in a case of this kind, and give him the benefit of his experience, to the mutual advantage of the whole community

A Settlement Reached

BEFORE going to press the news has reached us of the settlement of the strike in the anthracite coal mines. This will be received with great relief all over the continent, and especially in those districts that depend on getting their supply before the close of navigation. The situation is unfortunately far from clear as regards the distribution of the coal when work re-commences. The railways assert that they have ample cars to move all the coal that will be mined, but U. S. Government authorities are not so certain.

Economy must still be the watchword in Canada.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

CORLISS ENGINE GOVERNOR

Question:—Please describe the power method of adjusting the governor connections on a Corliss engine, and oblige an old reader.

Answer:—In the ordinary type of Corliss, the governing is effected by altering the position of the knock off cams on the valve spindle, to give an earlier cut off. The knock off cams are loose on the valve spindle, and can be turned to any position. They are connected to the governor by reach rods, and as the governor rises or falls the rods are alternately pushed or pulled, bringing the cams closer to the steam hook or further away, making cut off sooner or later. The ordinary method of adjusting is as follows:—First take out the safety stop from under the governor, allowing it to drop to its lowest position. When in this position the cams should be in such a position that the steam hook will not engage. That is the cams are so far round, by reason of the governor being in its lowest position, that the safety lug on the cam has come into position. If when the governor is in its lowest position, the steam hook will still engage, the reach rods must be adjusted until this fault is remedied. The reach rods are usually fitted with right and left hand couplings, so that they can be shortened or lengthened by merely turning in either direction.

Having made sure that the steam valves will not be operated when the governor is in its lowest or emergency position, the next step is to place the safety stop under the governor thus bringing the engine into its proper condition for starting. With the governor resting on the stop, and the engine on the dead centre at either end, the steam valve will be open the amount of lead that has been given it when setting the valves. Now turn the engine round by hand until the half stroke is reached. The knock off cams should release the valve when the half stroke is reached, or just a trifle before. If this is not the case, adjust the reach rods until they give cut off at half stroke. When these conditions are fulfilled, the governor should give the right cut off in any other position. When the engine is running, some further adjustments may be necessary in order to get the cut off at the correct place for the average load, but this can only be determined from the indicator cards.

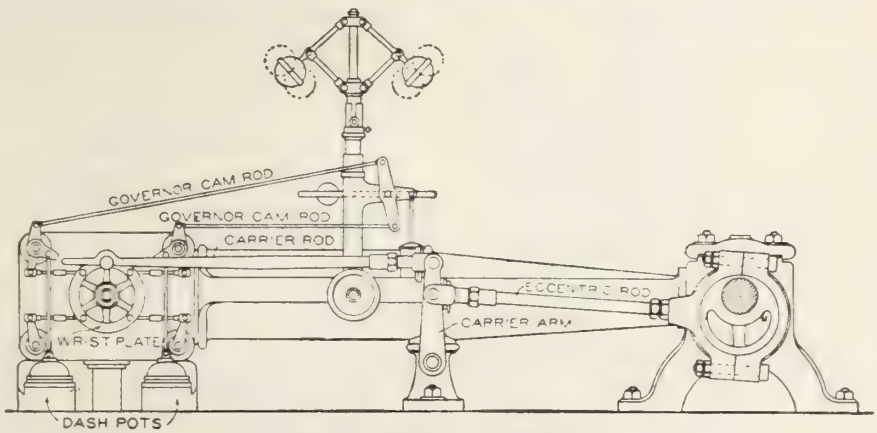


Diagram of Governor Arrangement.

In most governors the normal running position is about half way between the safety catch and the extreme top of the travel, and this can be used as a factor in setting the governor if necessary. Block the governor up to about half way between the position it occupies when resting on the safety catch, and the extreme upper position. Then adjust the reach rods to give cut off at the position of the stroke you want, usually about one quarter to three-eighths stroke. Make further adjustments from the indicator cards. Always remember that the governor, when below its safety stop, which is where it would be if the belt broke or slipped badly, should bring the knock off cams to a position where their safety lugs will be under the steam hook, so that no steam is admitted. Also that when the governor is in its lowest position, that cut off shall take place at half stroke. If these conditions are observed, the remaining adjustment can be made when the engine is running from the indicator cards.

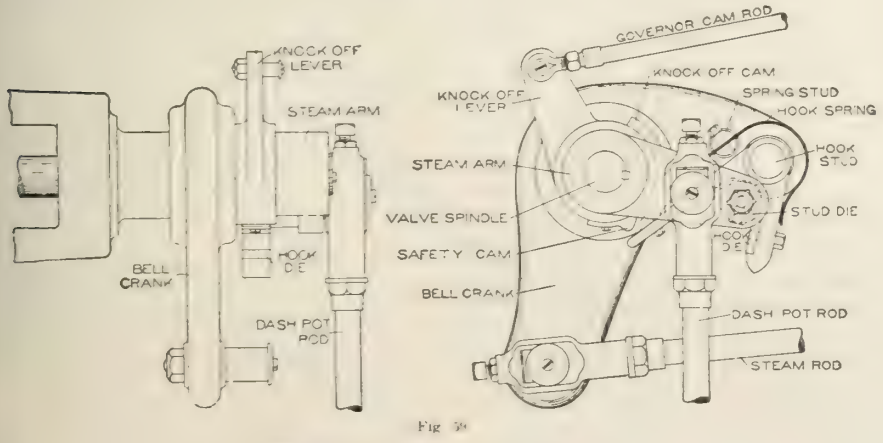


Fig 39

Enlarged view of steam hoop and cams.

STRENGTH OF CABLES

Question:—Will you please tell me in your question box how to find strength of cables, 1⅛th inches diameter, 6 strand, 18 wires to a strand.

Answer:—Cables for hoisting are usually made with 6 strands and 19 wires to a strand, while hauling ropes are made of 6 strands with 7 wires to a strand. The strength varies with the material that the wire is made of. The factor of safety used is about 5, that is the working strength is about one-fifth of the breaking stress. There is a stress on the rope due to bending as well as the direct tension stress due to the weight in a rope passing over a sheave, and for this reason certain minimum diameters of sheaves are recommended. A standard hoisting rope, as given in the tables

based on data supplied by the American Steel and Wire Co. of 1⅛th diameter, 6 strands, 19 wires to a strand, has a safe working load if of iron, of 3.7 tons, crucible steel 7.6 tons, extra strong crucible steel, 8.6 tons, plow steel, 9.4 tons, and monitor plow steel 11 tons.

There is thus a considerable spread between the different kinds of material. The area of a wire rope of 1⅛th diameter of 6 x 19 construction is .45 square inches, which works out for iron at 6.6 tons per square inch, for crucible steel 16.8 tons per sq. inch and so on.

An approximate rule for the strength of steel ropes is as follows:—The circumference squared of the rope divided by 2 gives the safe working load. Thus for a 1⅛th rope the circumference is 3.5 inches, and this squared is 12.25 and divided by 2 gives the safe working load at 6.6 tons. This is an English rule, and the tons would be 2,240 pounds, so that for the 2,000 lb. ton, the result would be 7.36, which agrees very closely with the working strength given in the tables. The same authority gives for hemp ropes the circumference squared divided by 20. For iron chains the number of eights in the diameter of the rod from which the chain is made, squared, and divided by 10¾. Thus a chain made of 1 inch stock would be good for a safe load of 8 x 8 divided by 10 or 6.4 tons.

It is the rule to test a piece of the wire rope of each size to destruction in a testing machine, and these tables have been formulated from the results of calculation and actual tests carried out in this way.

WATER IN CYLINDERS

Question:—What provision is usually made in vertical engines for getting rid of the water that accumulates on top of the pistons? Will not the presence of water in the cylinders materially impair the economy in the use of steam?

Answer:—When warming up, preparatory to starting, and during the first few minutes of running, water of condensation is taken care of by the drain cocks, and also a certain amount is carried away with the exhaust through the slide valve opening. When the engine is running up to normal speed and load, there is usually provision for a sudden slug of water in the shape of a spring loaded relief valve of ample size to relieve the cylinder. In some types of engine the valve itself is held up to the face by a spring, which is heavy enough to hold it under ordinary conditions, but will allow it to lift from the face under a sudden shock such as that caused by the presence of water in the cylinder.

As to the second part of your question, the answer is of course yes. However, we can guard against the presence of water, that is of water being carried over with the steam in large quantities by suitable separators. What we cannot avoid in ordinary engines with saturated steam, is the condensation of a certain amount of the steam on its admission to the cylinder, due to the cylinder walls having been cooled off during the exhaust period of the preceding stroke. This condensation represents a distinct loss. If there is water constantly present in the cylinder the loss is of course considerable, but generally, the condensation which has occurred during admission is re-evaporated during expansion. If the engine is a simple one, that is single cylinder non-condensing, this re-evaporation is of no value as the heat abstracted from the cylinder walls to perform the evaporation is merely carried away in the exhaust. If the engine is a compound one, we get the benefit of this heat in the next cylinder.

EXPANSION VALVES

Question:—Why cannot pressure regulating (or reducing) valves be used in refrigerating systems in place of the ordinary expansion valves?

Answer:—In the ordinary pressure reducing valves there is on each side of the valve a gas, but at different pressures. The temperature on each side is substantially the same. The greater number of these valves function by the difference in area of two diaphragm surfaces, counterbalanced by a spring or lever. These valves have large clear passages, and having practically the same temperature on each side, are not affected by unequal expansion problems. The expansion valve in the refrigerating system has a very different duty to perform. It has to pass a fluid under high pressure and comparatively high temperature, through a small opening to a chamber in which both pressure and temperature are considerably lower. The fluid in passing through the small orifice can be throttled down to an infinestimal amount, and the valve is so constructed that the slightest movement of the orifice gives a definite adjustment. There are no diaphragms, levers, etc., to cause trouble. It would be impossible to obtain the fine adjustments necessary with the ordinary pressure regulating valve, even if the problem of expansion and contraction could be overcome. In a nutshell, we might say that the ordinary pressure reducing or regulating valve is for handling large volumes of a gas at different pressure but approximately the same temperatures, while the refrigerating expansion valve is for handling comparatively small volumes of fluid, at greatly different temperatures on each side of the valve, and giving extremely close adjustments of flow to suit varying conditions.

NON-RETURN VALVES ON BOILER

Question:—When non-return valves are used in the connection between a battery of boilers and the steam header, in addition to the regular positive stop valves, should the non-return valves be placed next to the boilers, or next to the header? What are the reasons?

Answer:—The non-return valve is usually placed on the steam pipe, between the boiler and the non-stop valve, or in other words, next to the boiler. As the object of the valve is to prevent the steam from the header rushing into the boiler in case of any sudden drop in pressure, it is placed close to the boiler and the main stop valve. In fact it is very often made a part of the main stop. There is no particular reason why it should not be placed next to the header, except that it would not be possible to overhaul it when the boiler is shut down if it were between the boiler stop-valve and the header. It is much the same reason as makes us put the feed check valves against the boiler instead of at the pump.

SIZE OF MAGNET

Question:—Please inform me of the size of plunger, amount of wire, etc., for operating a solenoid to lift 5 lbs. on 440-volt, 60-cycle A. C. current.

Answer:—

Your question concerning the size of plunger, amount of wire, etc., for operating, a solenoid to lift 5 lbs. on a 440-volt A. C. circuit of 60-cycle is a most difficult one to answer; as there are so many varying factors, each of which must be firmly established before we can determine the results.

The first point which arises is—What is the permeability of the iron used for a core? This in turn will determine the value of the flux density, which in turn determines the exact "lifting power" of the magnet.

The permeability varies with each grade of iron, and can only be determined experimentally. This is the deciding factor, yet it varies within the following wide limits. Cast iron from 12,000 to 70,000 lines per sq. in., wrought iron, from 20,000 to 140,000 lines per sq. in.

Obviously therefore to attempt the correct magnetization of the core without being in possession of this figure, would be somewhat of a wild guess. The following is the detail of a solenoid for work under somewhat similar circumstances as mentioned in your letter.

Length of solenoid 5 in.; internal dia. 3 in.; external dia. 4½ in.; dia. of plunger 2⅜ in.; stop projects inside solenoid 1½ in.; air cap ¼ in.; turns of wire 144; volts 220; frequency 60; current 8 amps.; pull 5 lbs.

The general rules to follow are:—

(a) The traction of a magnet in pounds is equal to the square of the number of lines of force per sq. in., multiplied by the area of contact and divided by 72,134,000.

(b) The reluctance of a core or any portion thereof for inch measurements is equal to the product of the length of the core by 0.3132 divided by the product of its cross-sectional area and permeability.

(c) To calculate the magnetizing force in amp-turns required to force a given number of magnetic lines through

(Continued on page 38)

The Operators' Point of View

Test of Electrical Boiler

By M. C. ALLEN

ON ACCOUNT of the recent introduction and use of the high voltage electric boiler for the generation of high pressure steam for power and heating purposes the writer thought that the following description and test results might be of interest to some of your readers.

This particular boiler was especially fitted up for testing purposes and extreme care was used in the use and calibration of the measuring instruments. Some of the instruments used are similar to those used in a similar test on a coal-fired boiler and some are different on account of the difference of the material used to generate heat—electricity in one case and coal in the other. The sampling, weighing and analysis of coal are done away with as also is the gauging of draught, the analysis of flue gas and the weighing of ashes. All of this information being given by the reading of the wattmeter and then changed into B. t. u. or Boiler Horse Power.

The measurement of the water turned into steam is more difficult in an electric boiler than in the coal-fired boiler on account of the large loss in the blow off and the necessity of measuring the loss to get an accurate idea of the performance of the boiler.

The blow-off water usually leaves the boiler at a temperature above 212 degrees and in addition sometimes contains a certain part of the heat of evaporation which is given off as steam as soon as the water leaves the boiler and the pressure reduced to atmospheric. An accurate method of measuring the heat loss would be by means of a condenser. The test figures will show that it is considerable. Of course the steam generated can be measured by a steam flow meter and corrected for moisture and pressure, but to give an accurate and complete test report the blow-off should be determined. The large quantity of water blown off is necessitated by the type of construction of the boiler and the use of high tension electricity for steam generation. The generation of steam by electricity in the boiler on which these tests were made depended on the resistance of the water to the passage of the electric current and clear water has a higher resistance than muddy water. The particles of sediment in the water form a good conductor for the electric current and if the water is allowed to become too muddy it will probably result in the current arcing from electrode to the boiler shell and result in the destruction of the boiler. This condition necessitates the frequent use of the blow off valve to keep the water clean.

The feed water for the test may be measured, weighed, or metered as desired. In these particular tests it was measured in a calibrated tank and pumped from there to the boiler. The dryness, temperature and pressure of the steam were taken in the usual manner.

The following are the average results obtained:

Duration of test—5 hrs. 54 minutes.

Average Pressures, Temperature, Voltage, K. W., etc.

Steam pressure by gauge—124 lbs. per sq. inch.
Temperature of feed water—120 degrees F.
Temperature of blow-off water—187 degrees F. (when measured).
Average voltage—5,900.
Average amperes—1,254.5.
Average K. W. hours—12,425.
Percentage of moisture in steam—4.6%.
Quality of steam—95.94%.
Temperature of steam in calimeter—228.9 degrees.
Pressure in calorimeter—5 lbs.

Total Quantities

Weight of feed water supplied to boiler—251,140 lbs.
Total water blown off from boiler—32,605 lbs.
Water from steam separator—475 lbs.
Water carried over in steam—8,950 lbs.
Water turned into steam allowing for loss of blow-off, trap and moisture in steam—209,110 lbs.
Steam generator per hour—35,700 lbs.
Factor of evaporation—1.17.
Equivalent of evaporation per hour—41,700.
Boiler H. P. developed—1.210.
K. W. required per B. H. P. hour—10.36.
Boiler efficiency—94%.
Rated capacity of boiler—1,500 H. P.
Per cent. of rated capacity developed—81%
K. W. hours required to generate 1 000 lbs. of steam at 149 lbs. pressure.—349.

Comparative Cost of Steam and Electric Power

With coal at $8.00 per ton and a fair boiler and operating efficiency, steam may be produced for about 50c. per 1,000 lbs. from and at 212 degrees F.

To produce steam at this figure by electric power the cost would have to be about $9.35 per h. p. year. This figure is much lower than the rates usually paid for electric power but if power is purchased by contracting for a certain number of h. p. for a certain time an electric boiler may be profitably operated, particularly if the power requirements are not up to contract. A 1,500 h. p. electric boiler occupies less space and requires less care than a 300 h. p. coal-fired boiler.

These figures and description are intended to give a general idea of the operation of electric boilers in use at present in large pulp and paper and other manufacturing companies and also to give a comparison between electric and coal-fired boilers as regard cost of power, etc. They are not intended to cover any points of design, operation or mechanical description of the boilers.

HIGH WATER IN BOILERS

A great many articles have been written about the dangers of low water in steam boilers. It must be admitted such danger is real and to be avoided as much as humanly possible by using all known precautions. Although high water has been responsible for about as much material damage as low water, little comparatively has been written about it. How many engine wrecks have been caused by high water we shall never know. How many steam mains have been ruptured by water hammer due to high water? Such an accident may lead to a boiler wreck and great property loss and it may be impossible to prove that high water was the cause. I imagine if it were not for the steam separators, high water would have many further serious losses charged against it. Of course high water or a foaming boiler can cause an engine wreck even where there is a separator in use as such a separator may not be of sufficient capacity to handle a large charge of water. A foaming boiler is very often due to the same cause as high water. that is, neglect on the part of the boiler attendant. A clean boiler seldom foams and attention to duty will prevent high water. Of

course there are exceptions. Some engineers have not a good word to say for the high and low water alarm. In my opinion their use has saved vast sums of money by preventing accidents. One of the reasons given against their use is that they are apt to make the boiler attendant careless. Just the opposite, I would think, for the alarm whistle will inform the chief if the boiler attendant is not attending to his duty. Another detrimental reason given is that such alarms can get out of order, and an accident occurs because of the attendant placing reliance upon it. The same can be said about the safety valve, but that is no reason why we should discard it. Believe me, high water is a bad condition, pretty near as serious and undesirable as low water, and it is a great deal more common. Some boiler attendants will fill the boiler to the highest possible level right up near the top of the glass. Especially is this so in some localities where there is no uniform call for steam. Where the consumption is nearly constant the experienced man generally has his feed set so that the water level is on the same lines. We always hear of a serious boiler explosion, or other serious damage caused by low water, but there are many cases of serious damage caused by high water that are never publicly charged up to the real cause. A defective fitting broken by expansion or contraction according to report is perhaps due to water hammer. Such an accident on a large high-pressure steam main might be nearly as serious as a boiler explosion.

C. A. S. E. PICNIC

Toronto, No. 1 Branch of the Canadian Association of Stationary Engineers held a most successful picnic in the Exhibition Park, Toronto, on Saturday afternoon, August 19th. A long programme of sports was run off, during the afternoon, while at the close of the strenuous exercises, an informal supper was served in one of the buildings.

While all the sporting events were good, the baseball game between those earnest competitors, the supply men and the engineers, supplied the cream of the entertainment. While there was some doubt as to whether it was indoor or outdoor, hard ball or soft ball, everybody enjoyed it. Mr. Gordon Keith, after receiving the ball on the point of his jaw, inclined to the view that it was a hard ball, or in any case, hard enough for him. Notwithstanding this inauspicious start, Mr. Keith had the courage to accept the position of umpire on bases.

After the usual preliminary conversation, the game was started, and the supply men speedily demonstrated their superiority. Mr. Jack Thompson, who was catching for the supply men, not only displayed great agility in fielding his position, but was a mountain of support to the pitcher by reason of the valuable advice which he freely dispensed. In addition to this, after every pitched ball, he delivered a lecture on the rules of the game, which was greatly enjoyed by everybody but the players.

The umpire behind the bat, Mr. Walter Blackgrove, was eminently fitted for the job, not from any particular acquaintance he had with the game, but because he is the possessor of a stern and forbidding presence, and a voice like the bos'n's mate of the "Billy Rough 'Un." At that it took him all his time to be heard above the raucuous shouts of the aforesaid Jack Thompson.

The result of the game was a victory for the supply men, but this was only made possible by the supply men enlisting the help of the editor of "Power House" over the protest of the engineers. With the sun fast sinking, and both sides showing signs of exhaustion, the editor came to bat, and produced the hit that brought in the run that won the game for the supply men.

This was extremely fortunate, as all the available pitchers and catchers on both sides had been used up, and there was no more room on the score sheet to put down further runs.

The following is a list of the prize-winners and the donors of same:—

(1) The Tallest Engineer—Mr. F. A. W. Taylor; steel rule in leather case; 2nd prize, Mr. Jno. Brown; one year's subscription to Power House.

(2) The Shortest Engineer—Mr. R. Mallory; steel rule in leather case; 2nd prize, J. T. Onyon; one year's subscription to Power House.

(3) The Stoutest Engineer—Mr. S. B. Hall; Veeder speed-counter; 2nd prize, Jno. Brown, book on "How To Eat and Reduce."

(4) The Thinnest Engineer—N. Smith; book, "An Engineer's Lamp;" 2nd prize, E. Hurst; one year's subscription to Power House.

(5) The Oldest Engineer—J. Halliday; "picture of the Duke and Duchess."

(6) The Oldest Woman—Mrs. W. G. Blackgrove; book, "Why Grow Old?"

(7) The Youngest Woman—Mrs. A. Martin; box of Cowan's chocolates.

(8) The Fairest Woman—Mrs. E. Osborn; box of Cowan's chocolates.

(9) The Darkest Woman—Mrs. T. H. Turner; a parasol of darker hue.

(10) Sphinx-like—Mrs. Jno. Brown; box of Cowan's chocolates.

(11) The Grand Tormentor—Mr. A. P. Black; Tantalus-glass (Ontario).

(12) Boys' Race (50 yards)—E. H. Perkins, Jr., E. Bruce and D. Perkins.

(13) Girls' Race (50 yards)—Annie Hurst, Annie Bruce and Bessie Clews.

(14) Youths' Race (100 yards)—Geo. Brown, Jr., E. Truelove and E. Bruce.

(15) Maidens' Race (100 yards)—Vera Rowe, Miss Wilkinson and Vera Harris.

(16) Men's Race (50 yards)—Jno. Thompson, A. Martin and A. Hunter.

(17) Dairymaids' Race—Mrs. E. Osborne, Miss O. V. Harris and Miss M. Wilkinson.

(18) The Supplymen's "Hop-skip-and-jump"—F. Downs (20 ft. 7 inches), A. Martin (20 ft. 5 inches), and Mr. Jno. Thompson, President of the Supplymen's Assn., (20 ft.).

(20) The exact steppers were:—H. Chandler (90 ft. 11¾ in.), Jno. Brown (99ft. 11½ in.).

(21) The following won distinction as expert smokers:—H. Chandler, C. J. Parker and R. Dunton.

A valuable shaving set was donated as a prize by the Stephens Chemical and Manufacturing Co.

The Veeder speed-counter was donated by the McLean Stoker Co.

Mr. L. J. Ellis, Grand Secy. of the C.A.S.E.accompanied by his wife, from Hamilton, Ont., attended the picnic and was given the Engineers' "Tightener" or the "Grip" that never fails, in the shape of an 18 in. Trimo, as a token of appreciation by Toronto No. 1 C.A.S.E.

The B. F. Sturtevant Co., Hyde Park, Boston, have issued a bulletin descriptive of the Sturtevant underfeed stoker. The bulletin is designated No. 294, and contains a full description and several illustrations of the stoker. The stoker is known as the "Sturtevant R."

C. A. S. E. Members and Guests at Toronto No. 1 Branch Picnic.

Fuel Economy From Old Plant Equipment

By A. R. MUNFORD, U.S. Bureau of Mines

THE fuel economy of a plant may be better than its anxious friends realize. A superintendent of a Government plant, knowing that improvements in plant equipment had been made since his stokers were installed, was almost persuaded to substitute a new type. The Bureau of Mines was asked to ascertain the actual performance of the old stokers and found the plant already doing from three to five per cent. better than was promised for the new equipment.

The value of accurate knowledge of plant performance, and the need o equipment to weigh and measure quantities is thus demonstrated. The boiler and stoker efficiency was found to be 75 per cent., and the overall efficiency of the boiler, stoker, and economizer was 78 per cent. Both records are high, and are to be attributed to care in operation, to good working condition of the plant, and to the low rate of evaporation, which was only about two-thirds of the boiler's rated capacity.

The plant tested consisted of two water-tube boilers fired by means of overfeed stokers and equipped with a fuel economizer in the uptake. The boilers supplied steam to two large water pumps. One of these pumps was operating continuously, the second pump being used only intermittently.

The results of the tests, appended in the table below, were computed from readings collected over a period of 100 hours, from 8:00 a.m., Monday, May 30, to 12:00 noon, Friday, June 3, 1921. The flue-gas losses were determined by analyzing gas samples and observing gas temperature for 20 hours with one water pump running, and for 16 hours with two water pumps running.

The coal was weighed in large truck loads as it was brought from the storage space.

The water fed to the boilers through the economizers was metered by a water meter as it left the feed pump. The meter was tested before and after tests by weighing water passed through it. The meter was read every hour both day and night. The temperature of the water as metered was read every four hours during the test from a thermometer inserted in the feed pump suction line. The temperature of the water as it entered the economizer and as it entered the boiler, after passing through the economizer, was observed every 30 minutes each day and every four hours each night, by means of thermometers inserted at corresponding points in the boiler feed line. The pressure of steam in the boilers was read every hour both day and night.

The level of the water in the boilers was brought to the same point at the end of the test as it was at the beginning.

The temperature of the gases leaving one of the boilers was measured by an exposed copper-constantan thermocouple which was inserted into the center of the opening through which the gases left the boiler. The proximity of the two banks of boilers at the plant made it impossible to place a thermocouple in the corresponding position on the other boiler. This temperature was recorded every 30 minutes during each day.

The temperature of the gases leaving the economizer was measured by two exposed copper-constantan thermocouples inserted at the vertical center and spaced equally across the width of the opening through which the gases left the economizer. These temperatures were recorded every 30 minutes during each day, and their average was taken as the temperature of the gases leaving the economizer.

Samples of gas were drawn from each of the points at which temperature measurements were made; that is, one sample as the gases left the boiler and one as the gases left the economizer. The samples were drawn continuously over half-hour periods during each day and analyzed in a water Orsat.

The coal samples were obtained from a pile made by throwing one shovelful aside for every 20 that were thrown into the weighing car. This pile was reduced by crushing and quartering to the three five-pound samples sent to the chemical laboratories of the Bureau at Pittsburgh for analysis.

All of the ash removed from the furnace during the test was weighed and dumped in a single pile. This whole pile was reduced by crushing and quartering to the three five-pound samples on which the analysis was made.

The average figures and the results of the test are given in the following table:

Results of Tests of Two Boilers and Economizer

RESULTS OF TESTS OF TWO BOILERS AND ECONOMIZER.

	General particulars—equipment.		
1.	Type of boilers		Water tube
2.	Type of economizer		Green fuel economizer.
3.	Type of stoker		overfeed
4.	Heating surface, each boiler	sq. ft.	2,058
5.	Heating surface, both boilers	"	4,116
6.	Heating surface, economizer	"	1,843
7.	Grate surface, each stoker	"	45
8.	Grate surface, both stokers	"	90
9.	Production of draft		Chimney
	General Information.		
10.	Duration of test from 8.00 a.m. May 30 to noon June 3, 1921	hours	100
11.	Duration one pump and auxiliaries running	"	49-2/3
12.	Duration two pumps and auxiliaries running	"	50-1/3
	COAL		
13.	Total coal fired	lbs.	88,000
	Ultimate analysis coal as fired		
14.	Hydrogen	per cent.	4.5
15.	Carbon	per cent.	80.1
16.	Oxygen and nitrogen (by difference)	per cent.	6.3
17.	Sulphur	per cent.	.6
	Proximate analysis coal as fired		
18.	Moisture	per cent.	2.3
19.	Volatile matter	per cent.	17.0
20.	Fixed carbon	per cent.	72.2
21.	Ash	per cent.	8.5
22.	Calorific value	B.t.u. per pound	13,900
	ASH AND REFUSE		
23.	Total removed	pounds	6.000
24.	Carbonaceous content	per cent.	19
25.	Earthy matter content	per cent.	81
	FLUE-GASES AND AIR		
	Composition, per cent. by volume, dry		
	Gases leaving boiler No. 1 with one pump running		
26.	Carbon dioxide	per cent.	10.5
27.	Oxygen	per cent.	8.7
28.	Carbon monoxide	per cent.	0.0
29.	Nitrogen	per cent.	80.8
	Gases leaving boiler No. 1 with two pumps running		
30.	Carbon dioxide	per cent.	11.3
31.	Oxygen	per cent.	8.4
32.	Carbon monoxide	per cent.	0.0
33.	Nitrogen	per cent.	80.3
	Gases leaving boiler No. 1, average for test		
34.	Carbon dioxide	per cent.	10.9
35.	Oxygen	per cent.	8.6
36.	Carbon monoxide	per cent.	0.0
37.	Nitrogen	per cent.	80.5
	Gases leaving economizer with one pump running		
38.	Carbon dioxide	per cent.	9.7
39.	Oxygen	per cent.	9.8
40.	Carbon monoxide	per cent.	0.1
41.	Nitrogen	per cent.	80.4
	Gases leaving economizer with two pumps running		
42.	Carbon dioxide	per cent.	9.5
43.	Oxygen	per cent.	10.1
44.	Carbon monoxide	per cent.	0.0
45.	Nitrogen	per cent.	80.4
	Gases leaving economizer, average for test		
46.	Carbon dioxide	per cent.	9.6
47.	Oxygen	per cent.	10.0
48.	Carbon monoxide	per cent.	0.0
49.	Nitrogen	per cent.	80.4
	Excess air		
50.	In gases leaving boiler No. 1 with one pump running	per cent.	68
51.	In gases leaving boiler No. 1, with two pumps running	per cent.	65
52.	In gases leaving boiler No. 1, average for test	per cent.	66
53.	In gases leaving economizer with one pump running	per cent.	84
54.	In gases leaving economizer with two pumps running	per cent.	89
55.	In gases leaving economizer average test	per cent.	85
	Temperatures		
56.	Gases leaving boiler No. 1 with one pump running	deg. Fahr.	415
57.	Gases leaving boiler No. 1 with two pumps running	deg. Fahr.	496
58.	Gases leaving boiler No. 1, average for test	deg. Fahr.	455
59.	Gases leaving economizer with one pump running	deg. Fahr.	296
60.	Gases leaving economizer with two pumps running	deg. Fahr.	358
61.	Gases leaving economizer, average for test	deg. Fahr.	327
62.	Air in fire-room	deg. Fahr.	84
	FEED WATER AND STEAM		
63.	Total water fed to boiler	lbs.	906,800
64.	Total water fed to boiler per lb. coal as fired	lbs.	10.3
65	Steam pressure	pounds per sq. in.	174
66	Temperature of water entering economizer	deg. Fahr.	171
67.	Temperature of water entering boiler	deg. Fahr	211
68.	Heat transferred to 1 lb. of water in economizer	B.t.u	[illegible]
69.	Heat transferred to 1 lb. of water in boiler	B.t.u.	1,0[illegible]
70.	Heat transferred to 1 lb. of water in boiler and economizer	B.t.u.	1,056
	RATES		
71.	Coal fired per sq. ft. grate per hour	pounds	9.8
72.	Water evaporated per hour	pounds	9.068
73.	Heat transmitted per sq. ft. boiler heating surface per hr.	B.t.u.	2.2
74.	Heat transmitted per sq. ft. economizer heating surface per hr.	B.t.u.	0.2

(Continued on Page 38)

Progress in New Equipment

NOVEL TYPES OF CONDENSER

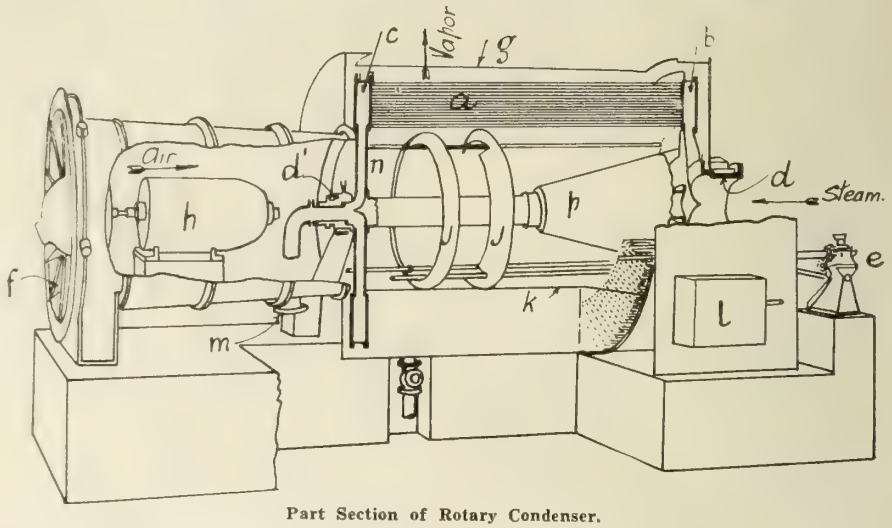
It is somewhat surprising, considering the continued advances made in the steam engine and steam turbine, that little out of the ordinary has been introduced in the condenser line. While admitting the efficiency and reliability of the orthodox types of surface and jet condenser, there are conditions which, to say the least, are not favorable to either type.

The jet condenser will use less water than the surface, but it must be of a quality which is not detrimental to the boiler feed if the condensate is fed back again, while if the quality of cooling water is limited, means have to be taken for cooling it in connection with surface condensers.

Both the ejector and barometric types present special advantages in certain cases, and are now pretty well known, the two types under discussion being comparative recent introductions having several interesting features.

The Ramsey Rotary Condenser

This condenser is claimed to be capable of maintaining a 29 in. vacuum with a consumption of cooling water of not more than 1 lb. per lb. of steam as against the usual 30 lbs. for a surface and 20 lbs. for a jet condenser.



Part Section of Rotary Condenser.

Referring to Fig. 1 it will be seen that it consists of a series of nests of tubes a so arranged to form an annular ring with a chamber b at one end to form a receiver for steam to be condensed, and a chamber c at the other end to form a receiver for the condensed steam and air vapor. Each of these chambers have trunnions d and d' formed on them which serve the double purpose of forming carriers, and also steam inlet and outlet for condensed steam and air vapor, the latter being withdrawn by means of an air pump.

The whole is capable of being rotated through the gearing at e, so that every tube is in turn immersed in the tank k containing condensing water and rises out of the tank covered with a film of water.

Exhaust steam enters through the trunnions d at one end, passes through the header b to the inside of the tubes a where heat transmission takes place, the heat from the steam passing through the tubes and evaporating the film of water on the external surface.

The condensing water which clings to the tubes having evaporated, the heat of evaporation will have been extracted from the steam passing through the tubes which becomes condensed and forms a vacuum. The condensed steam then passes along and out of the tubes into header, through trunnion d' to the outlet pipe m and thence to the air pump.

To remove the vapor of evaporation, and also to enhance the cooling effect on the tubes a fan f either belt-driven or driven by motor h, forces cooling air into the annular space n at center of tube nests. The air passes out among the tubes to an outer casing, the baffles j j and cone p assisting even distribution.

(Continued on page 36)

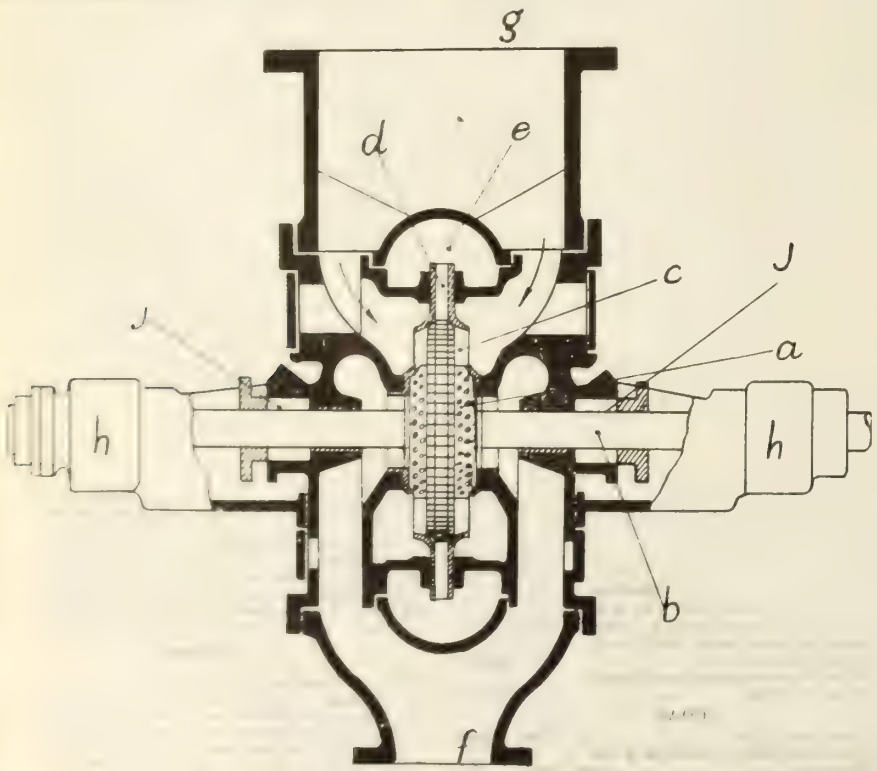
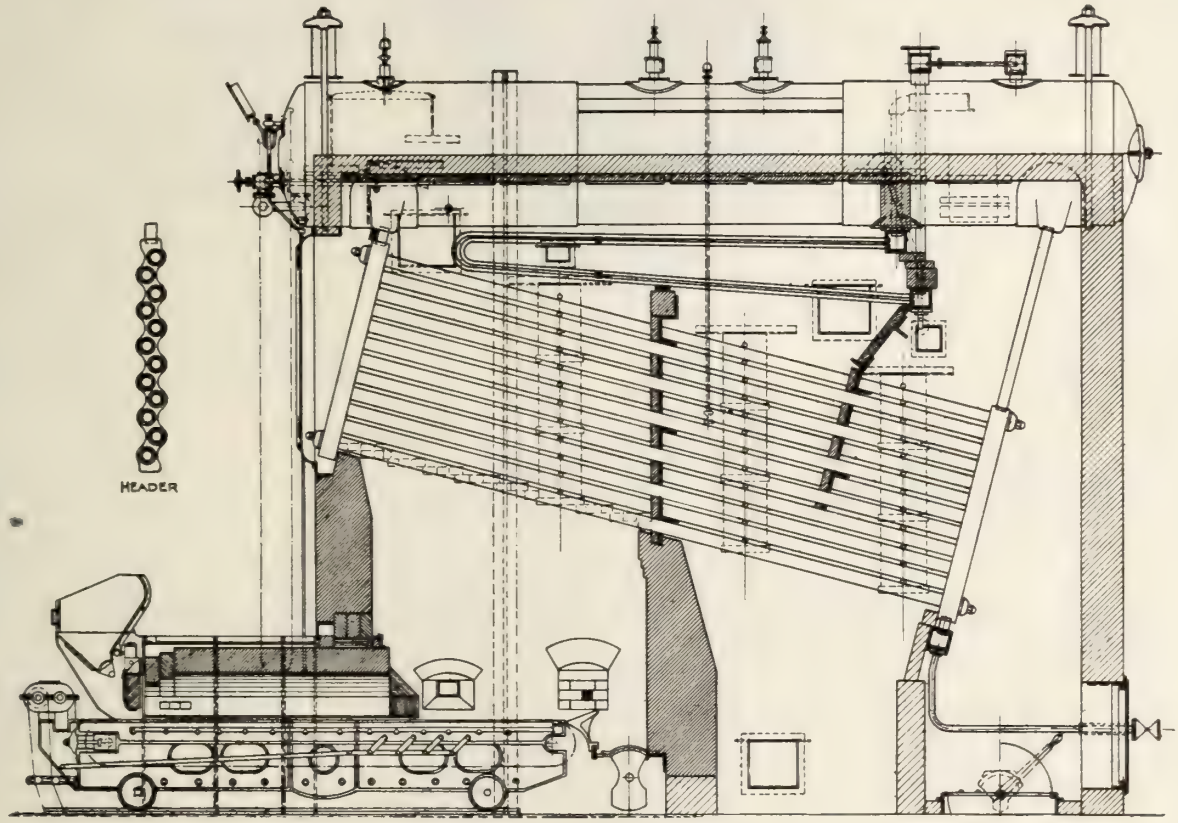


Diagram of impeller condenser.

BOILER EFFICIENCY



Standard Longitudinal Drum Sectional Header Boiler

The laws of each province provide that every boiler operated within its boundaries must be built to certain recognized standards. All details such as seams, riveting, fittings, etc., must meet the approval of their inspectors before they will pass any boiler as safe to operate.

The Civil Law also states the lowest grade of engineer you can employ and how often he is required to prepare each boiler for inspection.

The lawmakers are concerned with the safety of the public, they do not make it compulsory for you to buy economical plant. You are expected, on your own judgment as a business man, to buy boilers which will give you the highest degree of safety and the greatest return for your money in pounds of water evaporated.

Now just as there are Civil Laws to make sure no unnecessary risks are taken by the public, so there are certain acknowledged engineering laws for the design and construction of economical boilers and furnaces. The success of all such equipment depends upon the success with which these laws, which safeguard your money, are applied—practically.

Boilers made by B. & W. are readily accepted by the authorities, even in the provinces with the stiffest requirements, because they are designed with a higher factor of safety than asked for, and no steam apparatus is made of better material or with more care. Every part is readily accessible inside and out, and with a responsible man in charge to see they are kept clean, there is little possibility of serious trouble.

As regards the efficiency of B. & W. steam plant, we can only ask you here to consider two factors—(1) THE EFFICIENT FURNACE because the fuel is fed evenly and intermixed with a proper amount of air while burning. Perfect combustion is produced and the fuel all gasified in the large combustion chamber before the heating surfaces are reached. (2) THE EFFICIENT HEATING SURFACE because of the proper circulation of the water and hot gases with reference to each other, and because they thoroughly interpenetrate each other, due to the arrangement of the baffles and the manner in which the tubes are staggered.

Babcock & Wilcox, Limited

Head Office for Canada: St. Henry, Montreal

Branch Office: Bank of Hamilton Bldg., TORONTO

A NOVEL CONDENSER

(Continued from Page 34)

The water in k is kept at a constant level by the ball valve 1. The tubes a are made of brass, copper or other good heat-conducting metal, and they are carried by means of tube plates fixed to headers b and c, the latter having hollow trunnions concentric with the annular rings of tubes.

These trunnions are carried on pedestals attached to the tank which forms the base of the apparatus. The headers b and c are divided up by means of vanes, forming the tubes into four or more nests, each nest in turn having the steam shut off by means of directing pipes which cause the steam to pass through the tubes which have left the water in the tank and are covered with a thin film of water only.

The trunnions are made water tight by means of packing glands combined with a water seal.

The complete apparatus consists of condenser and fan as shown and an air pump. All three units can be driven by one small engine or electric motor, or separate motors can be applied to each unit as desired. For small and medium size installations where water is scarce the apparatus seems to offer special advantages, the high vacuum and the very small amount of water used being, of course, the special points in its favor.

The Rotary Jet Condenser

This is quite a different proposition to the one previously described. The chief aim of the designers in this case has been to produce a machine that will condense the steam in the minimum of space with a low expenditure of power and in the simplest manner. It is really a development of the Rees-Roturbo centrifugal pump and by referring to Fig. 2 it will be observed that a single rotating portion of the apparatus performs three distinct functions. This rotating member consists of a hollow impeller a keyed on to the main shaft b.

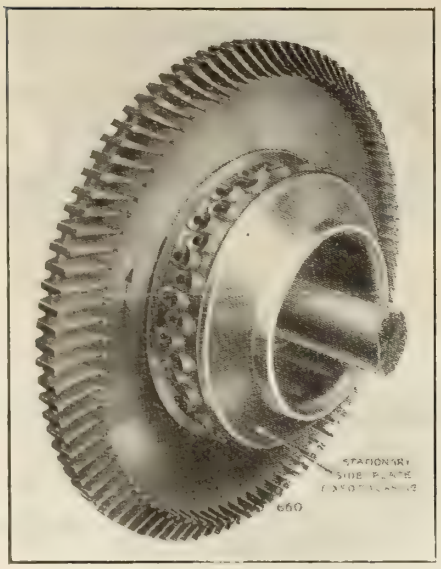
To the periphery of the impeller there is attached a disc c carrying a series of fan blades, the combination of impeller, disc and fan blades forming one complete rotating member.

A general view of the impeller is given in Fig. 3 (electro).

Concentric with the rotary portion of the air pump are a series of fixed blades or diffusers d and concentric with these again is the pump casing e communicating with the outlet.

The operation of this pump is somewhat peculiar but very effective. As soon as the impeller is run up to speed the water is drawn in through the branch f and enters the impeller axially at the sides and issues under considerable pressure radially through the holes shown in Fig. 3. These holes which form nozzles are arranged to impinge on a stationary deflector plate at a fixed distance from the central portion known as the pressure chamber.

A series of radial fans of water are thus formed, which, while still rotating with the impeller are projected across



View of impeller.

the space between the impeller and the inner circumference of the rim containing the fan blades. The steam entering through g and following the path of the arrows meets these rotating jets of water and is carried across the vacuum space to the inner edge of the fan wheel where the mixture of air, steam and water is picked up by the blades (see Fig. 3) and ejected through diffusers d into e and thence to the hotwell.

Thus the impeller lifts the circulating water, produces the jets and finally ejects the condensate.

By this process a perfect mixture of steam and water is ensured, which is an ideal condition for rapid condensation.

The shaft b is packed by glands at j each having separate water seals, and it runs in ring-oiling bearings h. The condenser may be driven by electric motor or high-speed engine, or even steam turbine.

The construction generally is of cast iron but the impeller a and diffuser d are of bronze. The discharge from e is at the side while a vacuum breaker (not shown) is also provided. The discharge is dealt with either by a cooling tower or spray coolers as desired, the former, of course, requiring a separate pump, otherwise no separate lifting pump is required, while the machine is noiseless and capable of utilizing dirty injection water.

Duplex condensers of this type have been built capable of dealing with 90,000 lbs. of steam per hour giving a 28 in. vacuum, the smallest size having a capacity of 4,000 lbs. of steam per hour with a 26 in. vacuum.

BELT DRIVE ECONOMIES

By N. G. Near

Very often, when installing a new driving pulley on a lineshaft in the machine shop the problem of proportioning the driving elements, not only for first cost of installation, but for economical upkeep arises. Generally the diameter of the pulley is assumed and the width of the belt is determined by a formula or heavy, wide, expensive belt. Since the rule of thumb. This often results in a revolutions per minute of the shaft are generally fixed, they cannot be changed without altering practically the entire arrangement in the machine shop. By increasing the diameter of the pulleys, a greater lineal speed of the belt is attained. This also increases its driving power per inch of width and so will allow a narrower, less costly belt.

The writer knows a company that wanted to transmit 20 horsepower from a shaft running at two hundred revolutions per minute to another shaft thirty feet away which was to be run at the same speed. The man who had had considerable experience with belts, and who should have known better, used his "judgment," which told him that two-foot pulleys would be sufficient for the job, and on those pulleys he would use a ten-inch double ply leather belt. He struck the belt width fairly close because a good rule to follow for selecting double-ply leather belts is to allow each inch in width, running at 500 ft. per minute, to transmit one horsepower.

The peripheral speed of a two-foot pulley running at 200 revolutions per minute is 1,255 feet per minute. Each inch in width will, therefore, transmit 2.5 horsepower and a ten-inch belt would easily transmit five horsepower. This man's judgment was, in this case, on the side of safety, but his judgment was not on the side of dollars and cents of economy. "How much will it cost?" he was asked by his superior. "Two hundred and forty-five dollars," was his answer. A little figuring on the part of the man higher up who happened to be better versed in belt matters showed that by using a fifty-two-inch pulley, and a seven-inch belt, the cost would be only one hundred and sixty dollars. The eighty-five dollar difference decided the question in favor of the larger pulleys, to be sure. Of course, there is not always room for as large pulleys as extreme economical considerations would dictate but often larger pulleys may be used to advantage.

The Atlas Engineering and Machine Co., Toronto, have purchased the patent rights and manufacturing rights for the Atlas Positive Circulators for hot water heating, and are now placing them on the market. The Atlas Circulator is the invention of H. H. Angus, B. Sc., Toronto, and consists of a circulating pump direct connected to a motor, the impeller of the pump being of a special design. It is of a conical shape, and will allow water to flow through it freely by gravity when the pump is not in use, so that a stoppage of the pump will not interfere with the circulation in the system. Deflector blades are fitted to impart a straight way motion to the water after leaving the impeller. It is claimed that a much higher efficiency can be obtained in the ordinary hot water heating system by the use of this circulator. The impeller shaft is mounted on ball bearings, the shaft being of special non-corrosive metal, and the bushings of phosphor bronze.

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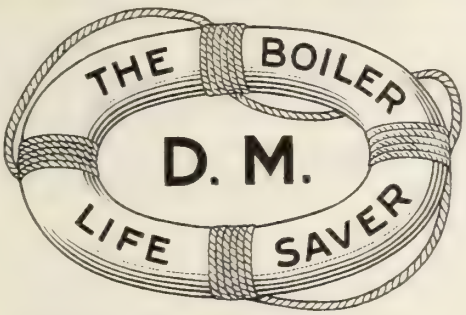

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AN EMERGENCY FUEL

As an emergency fuel, a mixture of fuel oil with fine coal in as large proportions as the coal will absorb and hold is suggested by the United States Bureau of Mines to steam coal users and gas manufacturers to augment their fuel supply during the present shortage.

Slack coal that has a high percentage through an 8-mesh screen, or which may be crushed to sizes of one-eighth inch or less, will take up in oil from 30 to 40 per cent. of its own weight and make a fuel high in calorific value. Coarse, slack coal, however, as judged by a representative sample from the Pittsburgh market, will absorb oil to only 3 to 10 per cent. of its own weight, which would give a fuel having only about 4 to 15 per cent. increased heating value. The finer the size of the coal, therefore, the larger is the amount of oil which will be held. Tests made by the Bureau of Mines at its Pittsburgh experiment station indicate that the mixture can be made with either bituminous slack or anthracite culm.

This method bears a relationship to the Trent process of purifying coal by fine grinding and amalgamation with oil, now in operation at a plant at Alexandria, Va., which has demonstrated the success of a combination of oil and coal for steam-making, gas manufacturing and other fuel purposes. The present emergency proposal does not contemplate the cleaning process, but involves merely the simple mixing by shovel or concrete mixer. The Trent Corporation has volunteered to assist the government in advising in the use or application of oil-coal mixtures, and to waive during this emergency any claim of infringement of its process which may or may not be involved by the simple mixing of fuel oil and coal, without reference to cleaning.

An oil refinery at Baltimore, it is reported, mixed by shovel a ton of heavy Mexican fuel oil with two or three tons of western Maryland slack coal, and used it successfully in a switch engine. At the experiment station of the Bureau of Mines at Pittsburgh, it was found that mixtures containing one ton of Mexican fuel oil and four to five tons of Pittsburgh slack coal could be used in a hand-fired furnace.

In using oil-coal mixtures, the fire will smoke badly after firing, or while breaking up the coke bed from time to time. From such limited amount of testing as has been done by the Bureau of Mines, it was shown that careful firing is required to prevent continuous smoking. Experimenting must be done in each case to determine the best method of firing.

Chain grates and certain other automatic stokers are probably well adapted to handle the oil-fuel mixture if the bin and feeding devices are suitable. Oil-fuel mixtures will not fire spontaneously, but undoubtedly care should be exercised to ventilate bins where external heat may tend to drive off lighter gases, although the fuel oil which is on the market has had the lighter oils distilled from it.

Anthracite culm or dust which would sift through ordinary grate bars can be used successfully when mixed with the oil, as the oil causes it to adhere and the oil residue cokes as soon as heated. Oil and anthracite mixtures are not smokeless with hand-firing, the Bureau of Mines tests indicate.

This simple mixture of fuel oil and coal is proposed by the Bureau of Mines merely as a temporary measure. While under conditions of normal fuel supply such a mixture probably would not prove satisfactory unless it involved the cleaning feature embraced in the Trent process; in places where fuel oil is available it can be used to piece out a poor coal supply without the changes in equipment necessary to convert boilers to oil burning.

SAFETY FIRST

"Safety first" is a good maxim in most things, but particularly so in relation to the investment of money. The rich may afford to speculate and to take the risks attendant on high rates of interest. Those whose means are moderate must be careful to see that there is absolute security in their investments. For such people there is no other form of investment which takes such a high rank, combining absolute security with liberal interest, as the bonds of the Dominion of Canada. Holders of Dominion

(Continued on page 38)

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Anthracite Waste Burned In Pulverized Form

A Test Run Over a Period of Thirty Days on the Boilers of a French Mine—The Fuel Contained a High Ash and Low Volatile Content

A SERIES of conclusive tests on burning mine waste, which have attracted considerable attention among French engineers, have recently been completed by La Societe des Mines de Houille de Blanzy, at Montceau-les-Mines. These tests clearly demonstrated that their mine waste of not over 1/16″ size, which corresponds in analysis to low grade American anthracite or river coal, could be burned in pulverized form under boilers with a combined furnace and boiler efficiency, ranging from 82% to 85%, although the boiler used was not equipped with either superheater or economizer.

The fuel employed corresponded, after drying, to the following average analysis:

Percentage of ash	29.2%
" " volatile matter	11.2%
" " fixed carbon	59.1%
" " moisture	0.5%
B. t. u.'s per pound	10,728
Fusing temperature of ash from	2,120° F. to 2,228° F.

The installation for the test consisted of one water tube boiler, B. & W. type, having 2,368 sq. ft. of heating surface. The test consisted of an uninterrupted 30-day run of 704 hours. During this period the hourly evaporation for each 10 sq. ft. of heating surface was 30.19 lbs. of water per hour, which exceeded the 29 lb. guarantee.

Evaporation of from 36 to 45 lbs. of water per 10 sq. ft. was easily attained for periods of several hours at a time.

The average evaporation per pound of coal was 6¾ lbs. of water, which also well exceeded the guaranteed performance of [illegible].

During the first 12 days of the test, the best method of operation and regulation was determined, and once having been attained was maintained until the end without difficulty. The hourly evaporation per 10 sq. ft. of heating surface showed an average of 30 lbs. of steam, and the average evaporation per pound of fuel was 7.38 lbs. of steam, which corresponds to an over-all efficiency of 82% for furnace and boiler.

During periods of more than 48 hours, the evaporation per pound of fuel was maintained between 7.61 and 7.65, which is equivalent to an efficiency of 85%.

During the whole time of the test, the ash was extracted easily—partly in a state of dust and partly in a spongy and vitrified state. The smoke leaving the stack was light and of a clear color and caused no deposit of dust in the neighborhood or surroundings of the installation. After cooling off, the combustion chamber was found in good condition and ready to operate again without making any repairs whatever. Considering the high efficiency obtained, this speaks very highly for the installation of the combustion chamber.

Coal preparing and burning equipment consisted of one 5-roller pulverizer, one dryer; two powdered coal feed controllers and two low pressure burners at the combustion chamber with the necessary blowers for supplying the air, for carrying the coal from the powdered coal feeders into the burners.

The equipment for the powdered coal installation was manufactured in France along American lines by the Societe Quigley-France (Emploi des Combustibles Pulverises) with the assistance and guidance of Quigley Fuel System, Inc., 26 Cortlandt Street, New York, and their engineer resident with the Quigley-France Company.

SIZE OF MAGNET

(Continued from Page 30)

a given permeability, multiply the desired lines of force by the reluctance.

(d) Total flux is determined by the number of turns, supply volts, frequence, as follows:—

$$\text{Flux} = \frac{\text{voltage} \times 10^8}{4.44 \times \text{frequency} \times \text{turns}}.$$

From these rules you will be able to calculate the ampere turns required to develop the number of lines of force necessary to lift 5 lbs. From this you will in turn be able to judge whether you have enough space on your solenoid to accommodate the amount of wire.

In connection with A. C. solenoids, special provision must be made to prevent humming, side vibration, and sparking. Effect of low power factor must be considered.

FUEL ECONOMY FROM OLD PLANT EQUIPMENT

(Continued from Page 33)

HEAT BALANCE, BOILERS AND ECONOMIZER, PER LB. COAL AS FIRED	B.t.u.	Per cent
75. Heat absorbed by boiler (and thermal efficiency boiler only)	10,460	75
76. Heat absorbed by economizer.	410	3
77. Heat absorbed by boiler and economizer and overall thermal efficiency	10.870	78
78. Heat lost in dry gases leaving economizer above fire-room temperature	1,260	9
79. Heat lost in steam in flue gases leaving economizer above fire-room temperature	470	3
80. Heat lost by not burning carbon monoxide	0	0
81. Heat lost in carbonaceous matter in ash and refuse	160	1
82. Radiation loss and errors	1,140	9
83. Total (items 77-82) and calorific value of coal	13,900	100

SAFETY FIRST

(Continued from page 37)

bonds bearing five and a-half per cent., maturing December 1, 1922, can re-invest their money at the same rate of interest by exchanging the old bonds for new ones running for either five years or ten years, as the bondholder may prefer. Arrangements for carrying out this exchange can be made through all the chartered banks.

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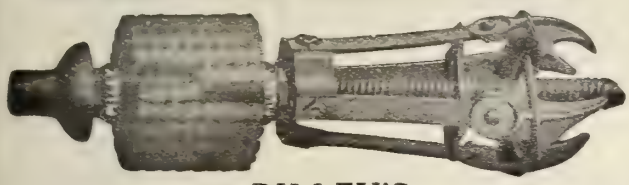

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Combination Flue Brush and Scraper

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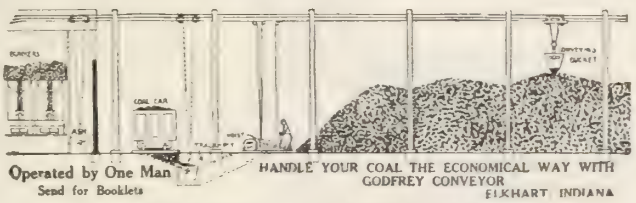

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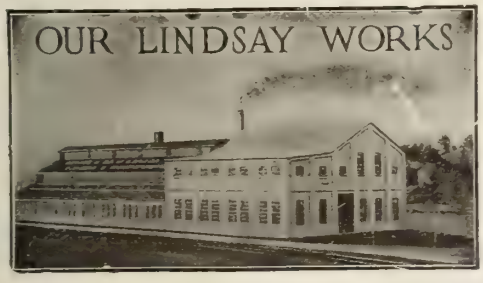

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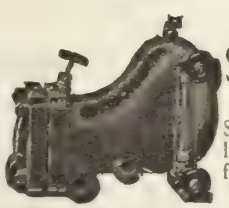

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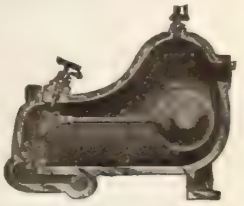

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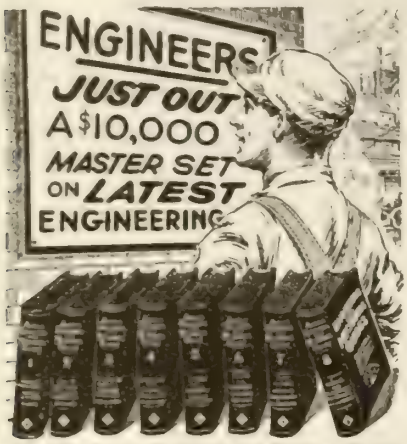

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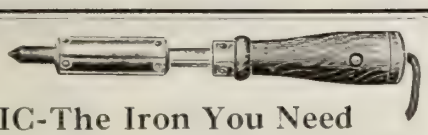

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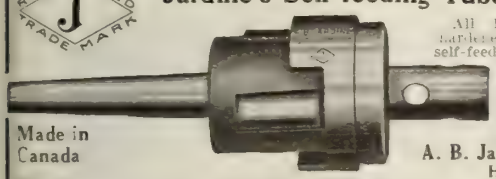

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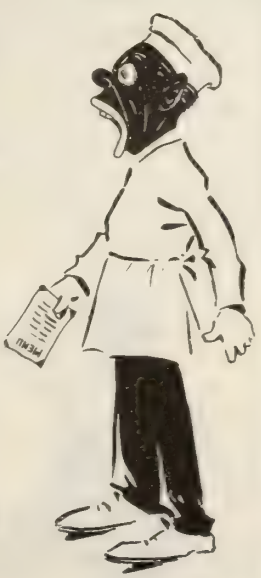

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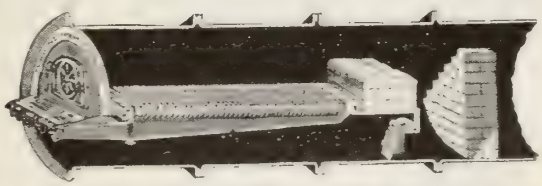

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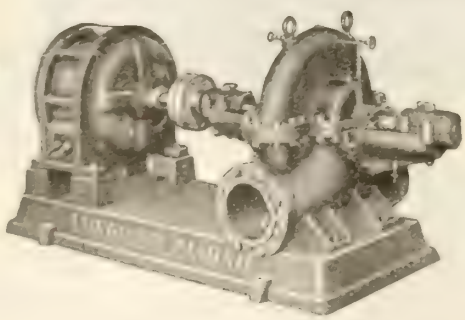
Centrifugal and Direct Acting



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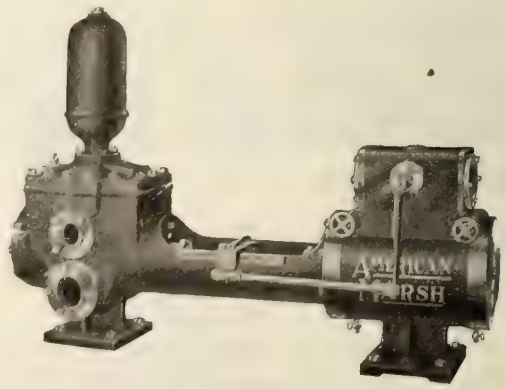

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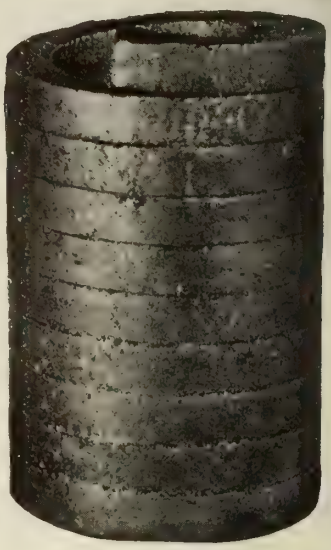
Style 100

for temperatures up to 450 and rod speeds of 400 feet per minute.



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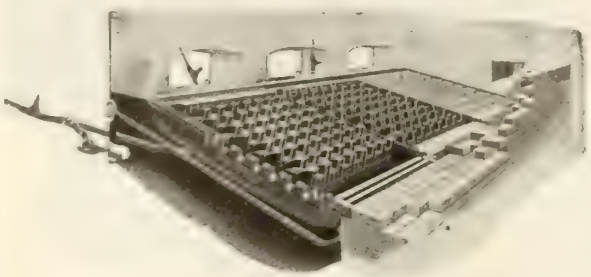

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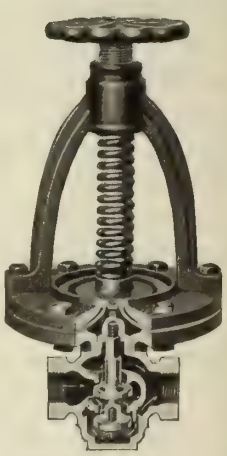

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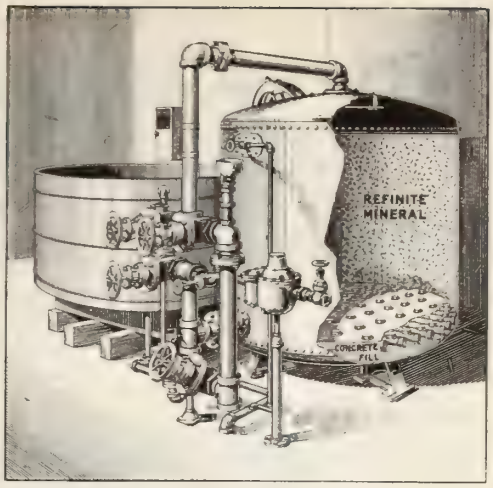

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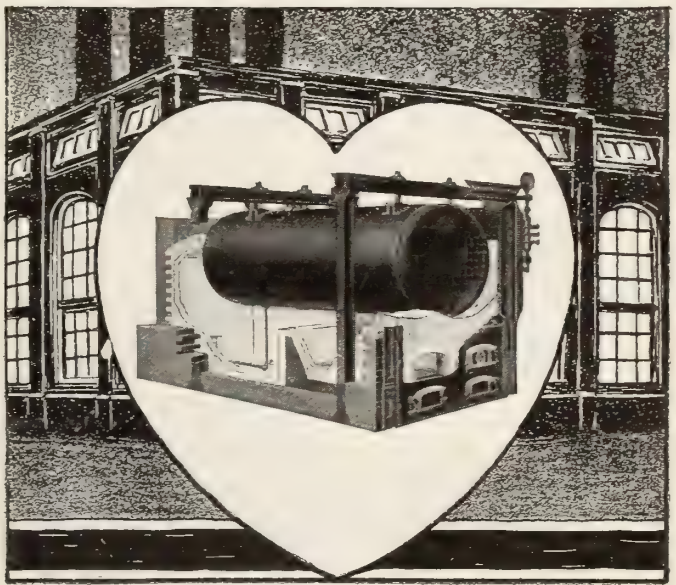

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CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd. Montreal

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply Ltd., Toronto
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. A., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Beveridge Supply Co. Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W.R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCullough Co., Galt.
Leonard & Sons, Ltd, E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd, Toronto.
Gelinas & Pennock, Reg'd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co. Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren Limited, Montreal, Que.

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N. Y.

CLEANERS, BOILER TUBE CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
R. C. Miler Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Waterous Engine Works Co., Brantford.

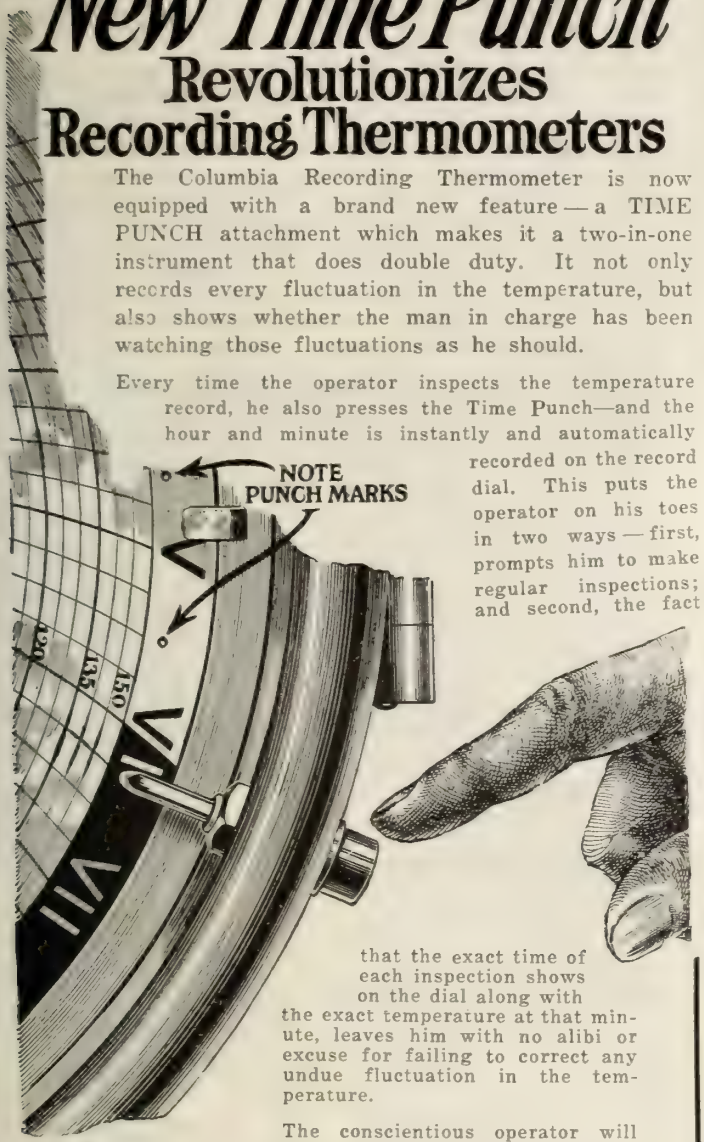
COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West Toronto.
MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Prantford, Ont.

New Time Punch Revolutionizes Recording Thermometers

The Columbia Recording Thermometer is now equipped with a brand new feature — a TIME PUNCH attachment which makes it a two-in-one instrument that does double duty. It not only records every fluctuation in the temperature, but also shows whether the man in charge has been watching those fluctuations as he should.

Every time the operator inspects the temperature record, he also presses the Time Punch—and the hour and minute is instantly and automatically recorded on the record dial. This puts the operator on his toes in two ways — first, prompts him to make regular inspections; and second, the fact that the exact time of each inspection shows on the dial along with the exact temperature at that minute, leaves him with no alibi or excuse for failing to correct any undue fluctuation in the temperature.



The conscientious operator will take pride in having the proof of his dependability put on record; while the man who is inclined to be careless or forgetful will immediately brace up when he knows there is a constant check on him. The result in either case is bound to be a more uniform temperature—less spoilage and damage, greater efficiency, lower operating costs.

THE Schaeffer & Budenberg MFG. CO.

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Makers of Columbia Recording Thermometers and Gauges with TIME PUNCH

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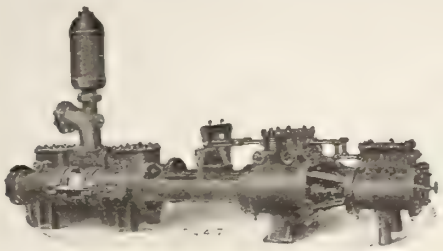
67-69 Frederick St. Phone: Main 2578

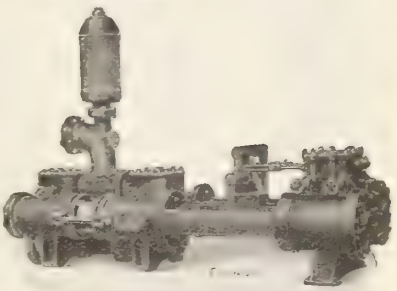
MONTREAL AGENTS:
Patton Mfg. Co. 284 Beaver Hall Hill

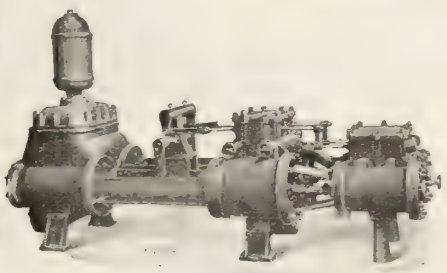
STEAM DRIVEN DUPLEX PUMPS POWER DRIVEN



How often have you waited "WEEKS" for a spare part?

Buy a McGowan and have their service department take care of you.





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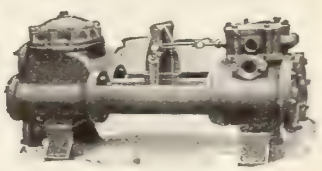
DUPLEX
STEAM
POWER

CONDENSING
NON-CONDENSING
COMPOUND
TRIPLE EXPANSION



For All Conditions of Service.

Pressure Patterns
Packed Piston
Semi-Corliss
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CINCINNATI, OHIO U.S.A.

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Can. Mead-Morrison Co., Ltd., Montreal.

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Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

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COLD STORAGE DOORS AND WINDOWS
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Laurie & Lamb, Montreal.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Ironbridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co. Ltd., Toronto

CONDENSATION RECEIVER
The Mason Regulator & Eng., Co., Ltd., Montreal.

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Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

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MacKinnon Steel Co., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.

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Godfrey Conveyor Co., 109-110 Richmond St. West, Toronto.
Godfrey Conveyor Co., Elkhart, Ind.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Imperial Rubber Co., Hamilton, Ont.

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Lunkenheimer Steam Gauge & Valve Mfg. Co., Cincinnati, Ohio.
Ashcroft & Budenberg Mfg. Co., Brooklyn, N. Y.

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The Jeffrey Manufacturing Co., Ltd., Montreal

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Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

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Babcock & Wilcox, Ltd., Montreal
Canadian Ingersoll-Rand Co., Montreal
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, GANTRY
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Canadian Ingersoll-Rand Co., Ltd., Montreal
The Mason Regulator & Eng., Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.

CRANES, OVERHEAD TRAVELING
Canadian Ingersoll-Rand Co., Ltd., Montreal
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Babcock Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

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Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaffer & Budenburg Mfg. Co., Brooklyn, N. Y.

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DROP- FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

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Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal
B. F. Sturtevant Co., Boston, Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
MacKinnon Steel Co., Ltd., Sherbroke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co., of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg., Co., Toronto.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

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Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Prantford.
Sturtevant Co., B. F., Toronto, Can.

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Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F. Toronto, Can.

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B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N.Y.

EYE BOLTS

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F. Toronto, Can.

FAN ENGINE REGULATORS
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Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
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Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Laurie & Lamb, Montreal.

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Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa
Graver Corp., East Chicago, Ind.
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittsburgh, Pa
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa

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Boston Plastic Fire Brick Co., Inc., Rome, N. Y
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal .
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
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Crane Limited, Montreal.

FITTINGS
Crane Limited, Montreal.

FITTINGS, CAST IRON
Crane Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

FLOOR AND CEILING PLATES
Crane's Limited Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co. Ltd., Toronto

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co.
Dominion Flow Meter Co., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Metaer Co., Toronto.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, tMch.
Sanford Riley Stoker Co., Worcester, Mass

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Canadian Johns-Manville Co. Ltd., Toronto
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HAND-HOLE
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Peidam Asbestos (Canada) Co., Toronto.
Canadian JohnsManville Co. Ltd., Toronto
Can. Steam Boiler Equip. Co., Toronto
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
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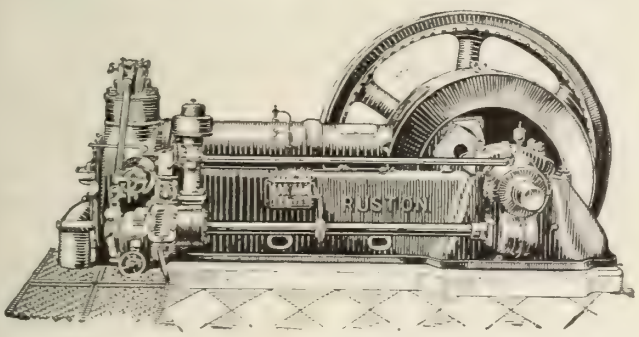

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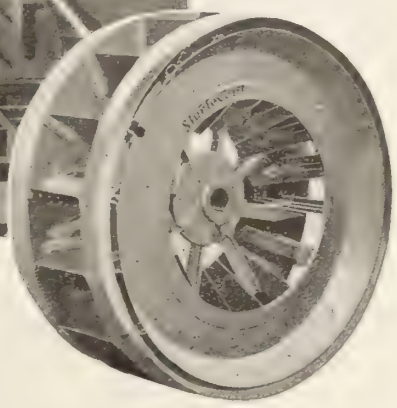

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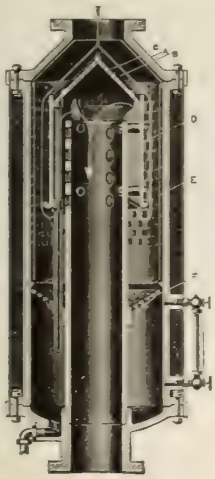

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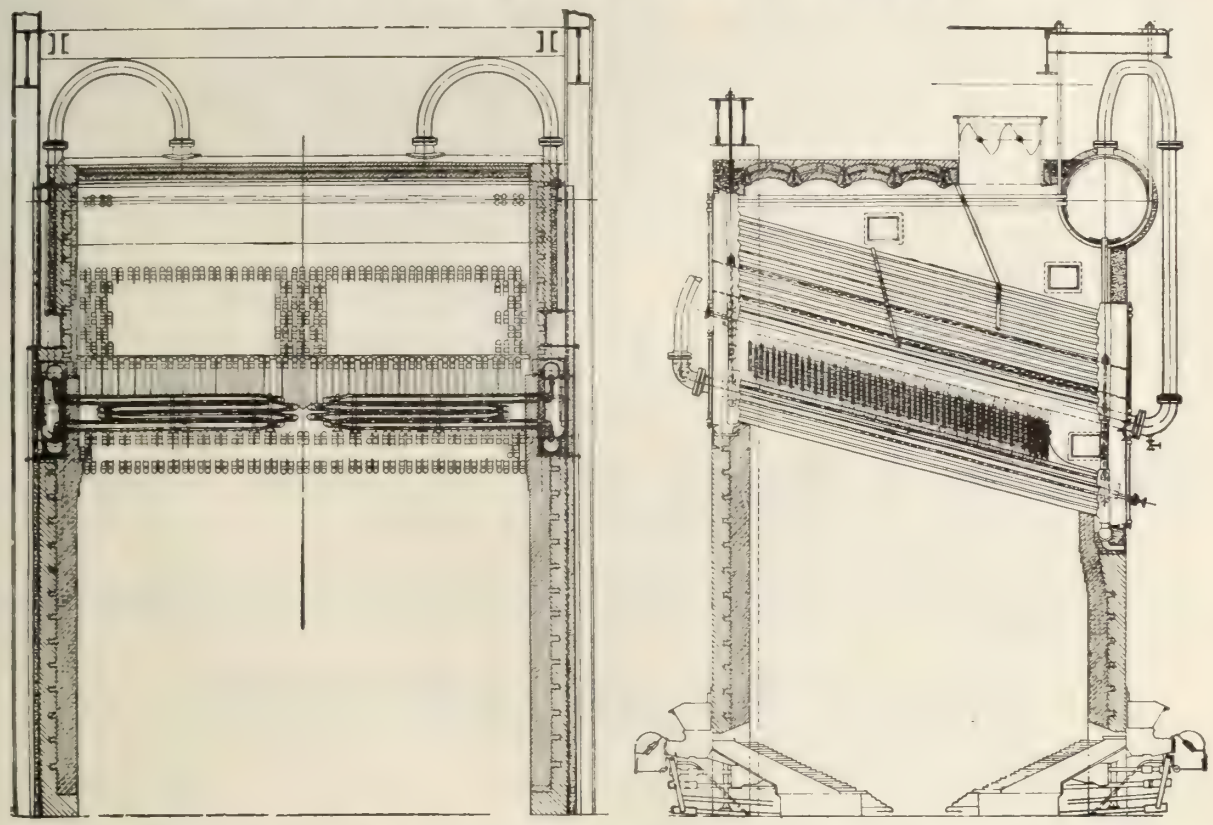

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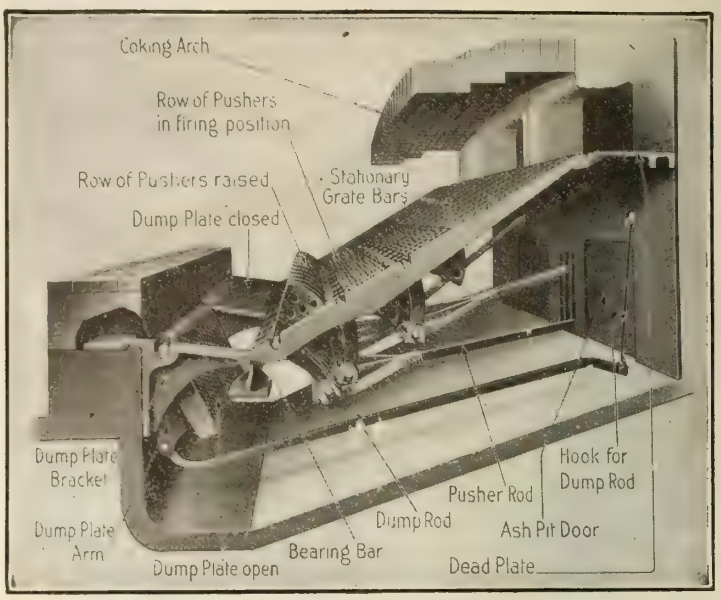

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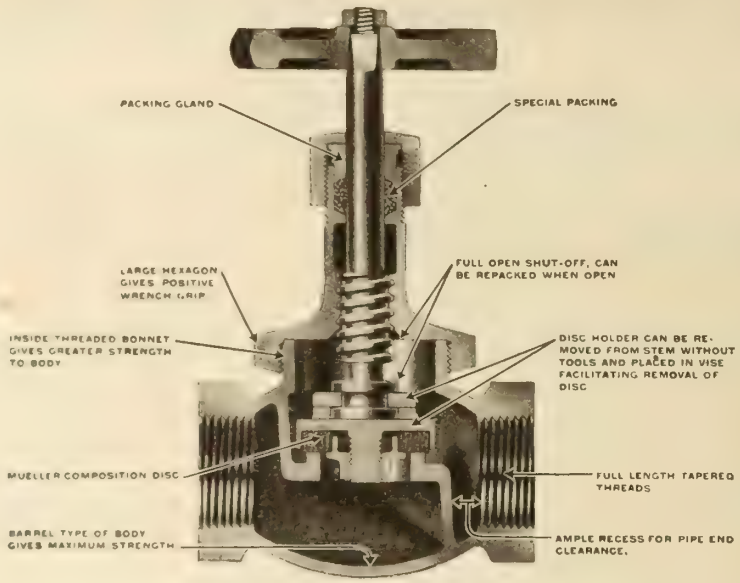
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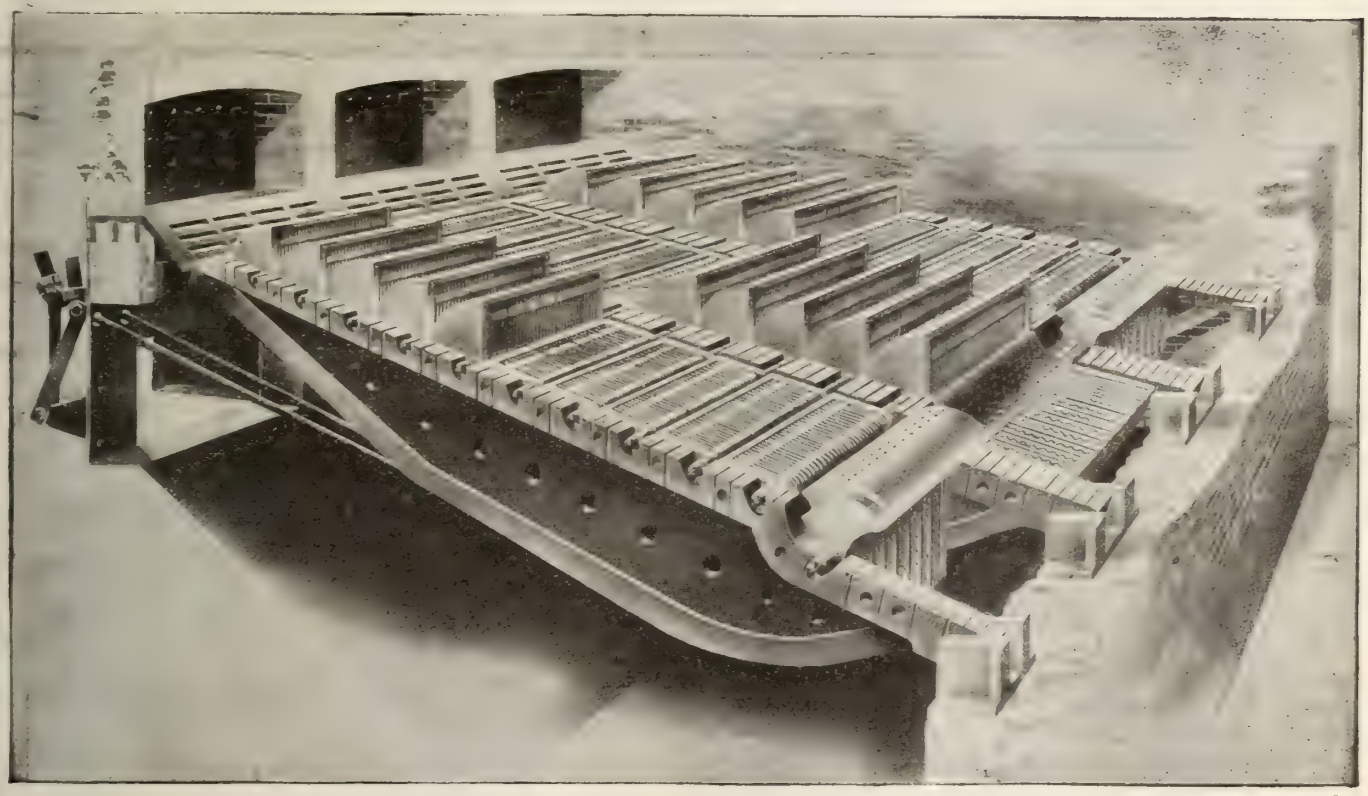

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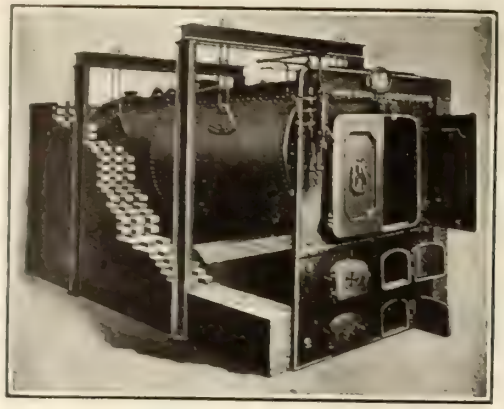

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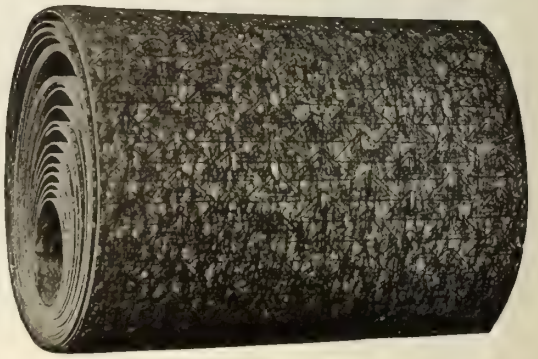

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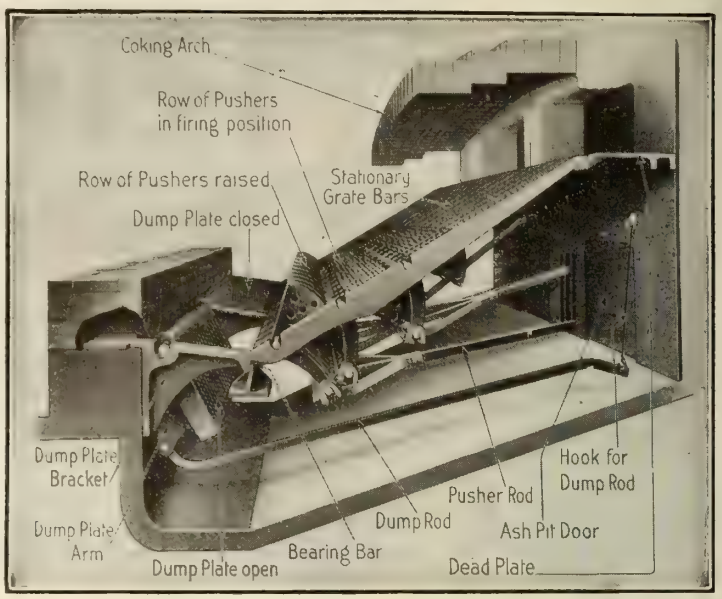

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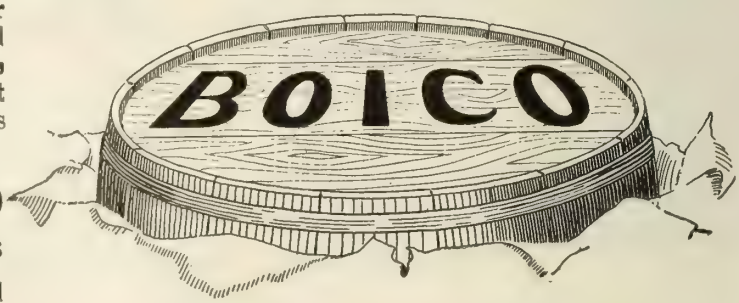

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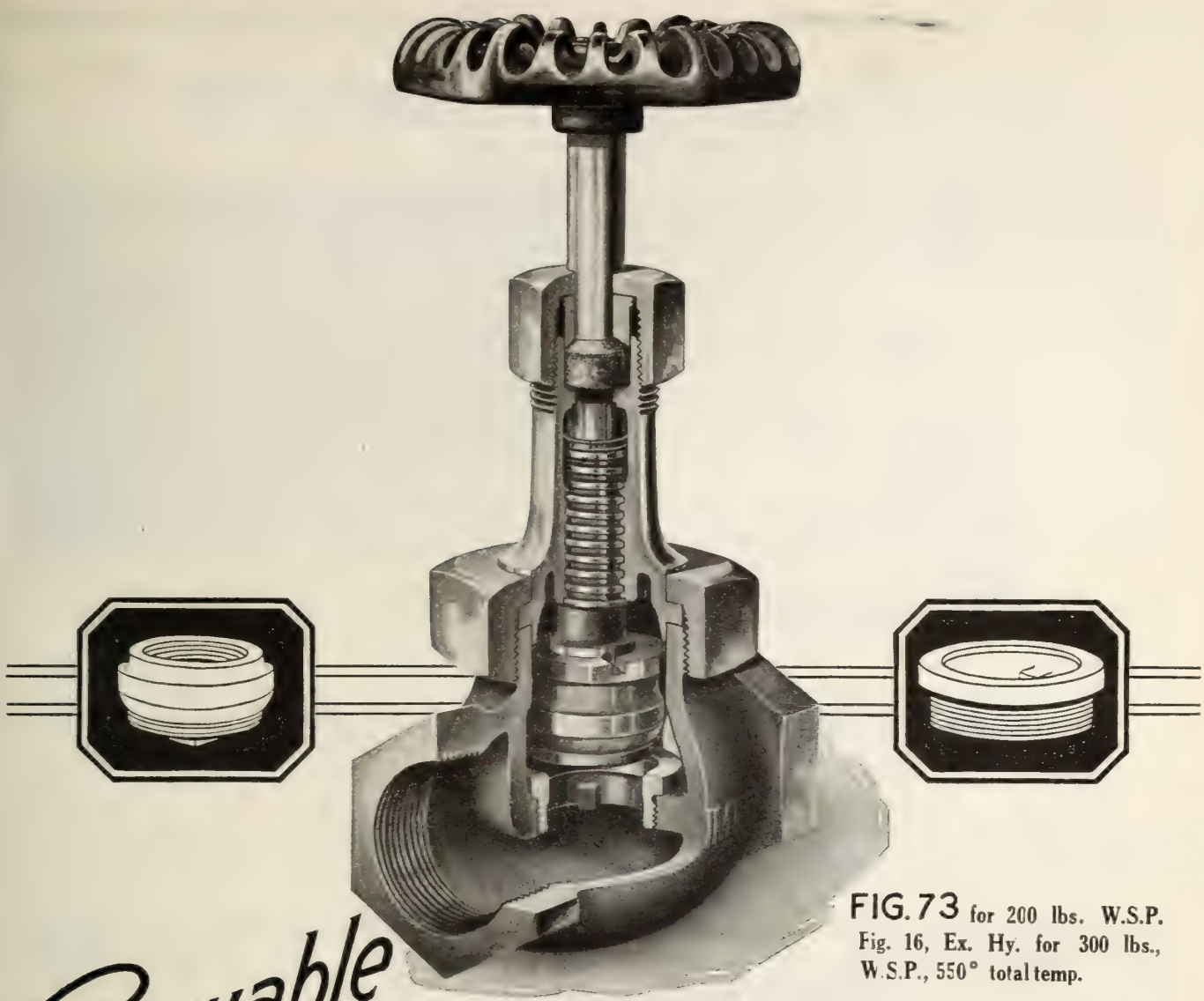

FIG. 73 for 200 lbs. W.S.P.
Fig. 16, Ex. Hy. for 300 lbs., W.S.P., 550° total temp.

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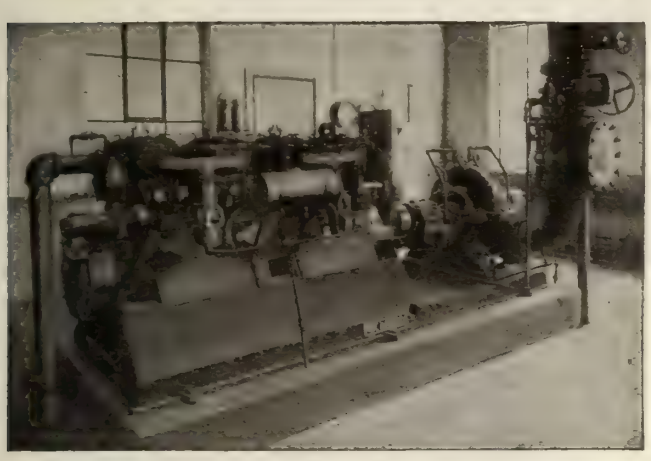

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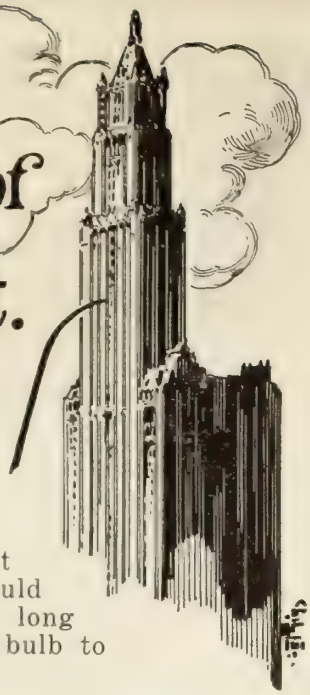

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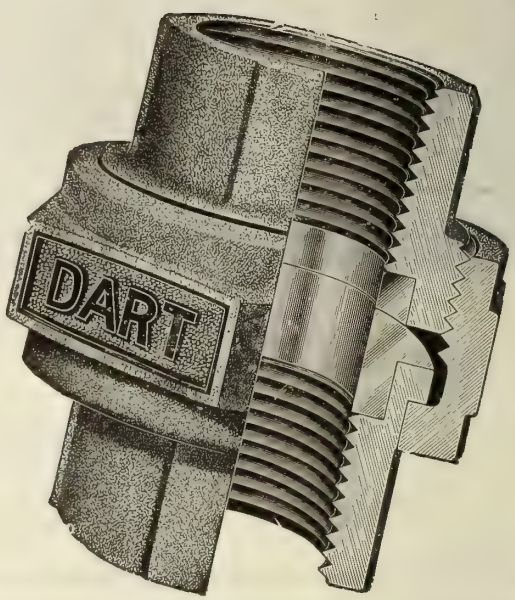

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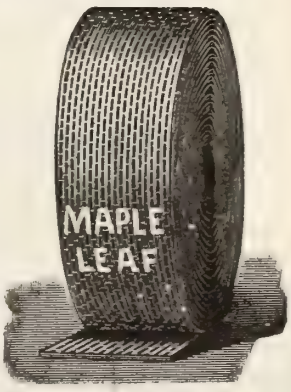

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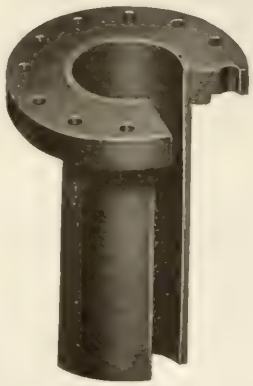
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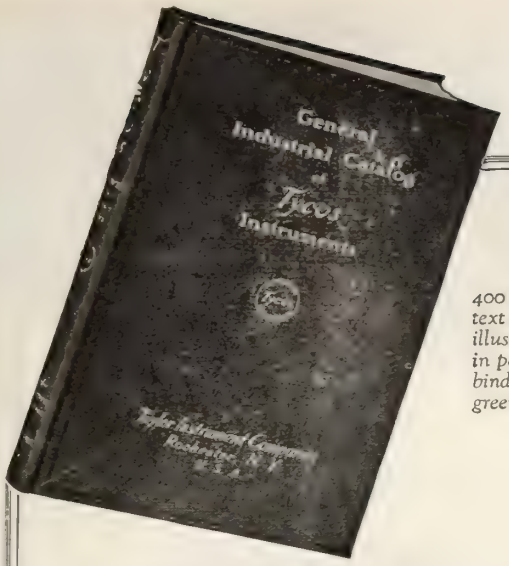

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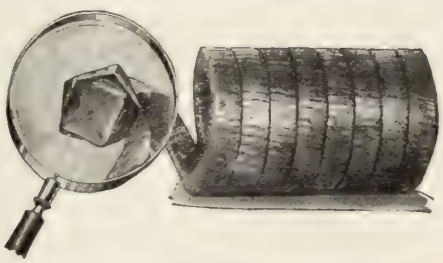

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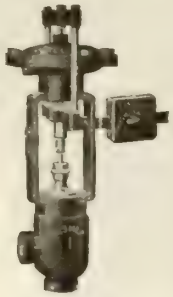

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Fisher Vacuum Pump Governor

(Type 8)

a prominent member of the Fisher line, is used in the vacuum heating systems of such well-known buildings as the Canadian Pacific Bldg., Toronto, Canada; Woolworth Bldg., New York City; North American Bldg., Chicago, Ill.; and many others. Judge it by the company it keeps.

Fisher Vacuum Pump Governor is super-sensitive. The extra-large diaphragm makes it so. As you see in the illustration it has lever and weight control. This control is positive—never changing—and we can guarantee an absolutely accurate regulation of vacuum.

This governor is made of the same high-grade materials found in other Fisher Steam Specialties. Type of construction allows us to furnish it with either globe or angle bodies. This is a convenience immediately recognized.

Write for book, "POWER PLANT SPECIALTIES," which tells all about this and other Fisher Specialties.

The Fisher Governor Company
937 Fisher Ave., Marshalltown, Iowa, U.S.A.

Agencies in all principal cities

A simple, inexpensive self-cleaning stoker

THE Jones "Standard Side Dump" Stoker meets the demand of Canadian plants for inexpensive, self cleaning stoker that saves fuel and labor.

The same retort, hopper, steam cylinder and ram that have proven so successful with the Jones "Standard" Stoker are used. Instead of the hand cleaned dead plates, sloping combustion grates and hand operated dump plates are used. Successive strokes of the steam driven ram move the coal rearward and upward through the stoker retort (shown above) as it undergoes the different stages of volatilization, coking and combustion. The ash is deposited on the side dump plates, and is dropped at intervals into the ash pit below. Only a slight, inexpensive excavation is necessary for the ash pits; Jones "Standard Side Dump" Stokers may easily and cheaply be installed under existing boilers.

High capacity, maximum efficiency, smokeless operation, rugged construction, low maintenance through lack of moving parts in fire, automatic control of fuel and air, and all other advantages of other Jones types are found in the "Standard Side Dump" Stoker. *Ask for Bulletins.*

On existing installations of Jones "Standard" Stokers it is possible to apply at very small cost the side dump attachments. *Write for folder.*

Under-Feed Stoker Co. of Canada, Ltd.
146 King Street West, Toronto

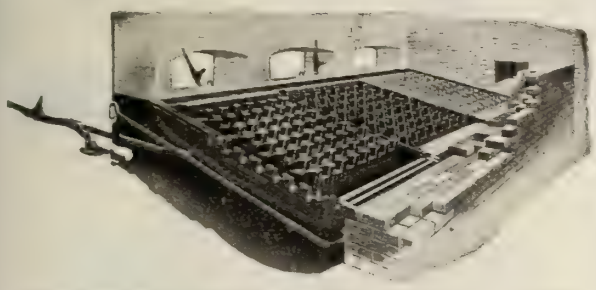
Alta. and West. Sask.: Mr. J. Twomey, Camrose, Alberta.
Man. and East. Sask.: W. W. Hicks & Co., Winnipeg.
British Columbia: E. A. Earle, Limited, Vancouver, B. C.
Que. and Mar. Prov.: The Cleaton Co., (Canada), Ltd., Montreal, Que.

JONES "Standard Side Dump"
Self Cleaning **Stoker**

Made in Canada

CoKal 'Chainless' Stokers

Self Cleaning *Hand Operated*



CoKal stokers can be furnished with or without hopper feeds

EASY TO OPERATE
INCREASE CAPACITY
ELIMINATE SMOKE
HIGH RATINGS
INCREASE EFFICIENCY
COST REASONABLE

SAVE COAL
INCREASE EVAPORATION
GUARANTEE RESULTS
UNIFORM FIRE BED
FIRES ALWAYS CLEAN
SOLVE BOILER PROBLEMS

The Best Hand Stoker Built

GELINAS & PENNOCK Reg'd.
207 St. James Street, Montreal, Canada

A Mallet and Trowel

AND A SUPPLY of Betson Plastic Fire Brick make the most durable boiler furnace lining, because it is all in one piece, free from cracks, seams, joints, moulded brick and fire clay. Shipped either mixed ready for use, or dry to mix with water (the cost is the same) from our warehouses in principal cities.

How to obtain Greater Efficiency, more power from the fuel burned, and how to save about 50 per cent. on repair and upkeep costs are told in our booklet. Send for a free copy.

Betson Plastic Fire Brick Co., Inc.
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PLASTIC FIRE BRICK

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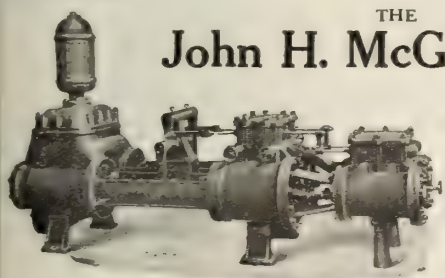
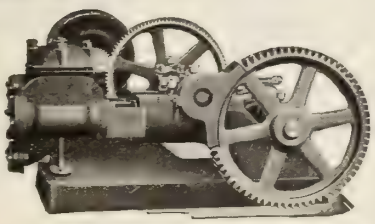
John H. McGowan Co.



Builders of Pumping Machinery

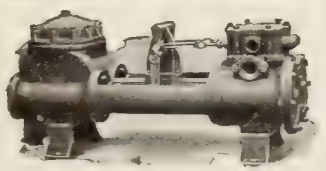
Cincinnati
Ohio, U. S. A.

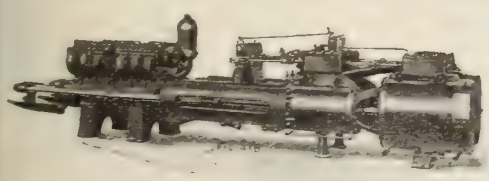


We are frequently in receipt of inquiries calling for pumping machinery built for continuous operation.

All McGowan Pumps are built for continuous operation.

Try a McGowan the next time you purchase.





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SCORED JOURNALS MADE SMOOTH

Magnolia Anti-Friction Metal is the one lining that completely fills in and smooths over scratches and irregularities in the journal surface. It has the peculiar property of imparting high polish alike to shaft and box surfaces and keeping the whole bearing cool and in prime condition.

Try a Magnolia lining on your next hot-box or "hopeless" case and you will quickly see why so many of our customers would use no other bearing metal even if others could be had for nothing.

Ask your dealer or write us direct.

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Pacific Bldg.

Montreal
37 Shannon St.

MAGNOLIA
ANTI-FRICTION
METAL
TRADE MARK

Look Today

Give that furnace the "once over" you have been planning, and if you find crumbling mortar and fallen bricks, you need

PLIBRICO JOINTLESS
FURNACE LINING

That's the material to use to make all parts of the boiler settings air and gas tight. It forms boiler settings that resist heat up to 3100 deg. Fahr., that permit the utmost production of steam at the least fuel expense, and that outlast laid-up fire brick many times.

Send for our book, L-72, on "Modern Furnace Building," and learn all about PLIBRICO. Our nearest representative will serve you FREE.

PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.

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JOINTLESS FIRE BRICK CO.
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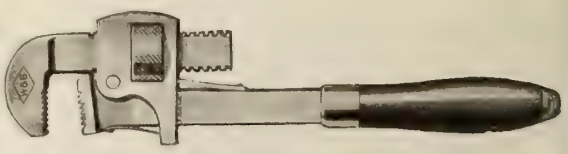

Williams' Stillson Wrenches

Are sturdy and dependable—well balanced—positive in grip—powerful in action.

The tough teeth retain their sharpness; they "bite" instantly, yet release readily.

Wood and Steel Handle Patterns—eight sizes, 6 to 48 inches. Ask for booklet.

J. H. Williams & Co.

LIMITED

"The Wrench People"

78 Thorold Road - St. Catharines, Ont.

Save Fuel

Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

CURTIS

Improved Damper Regulator

It is a simple, durable and effective device. Positive and automatic in operation.

Write for our 1922 catalog showing the Curtis line of Engineering Supplies.

JULIAN D'ESTE COMPANY
26 Canal Street Boston, 14, Mass

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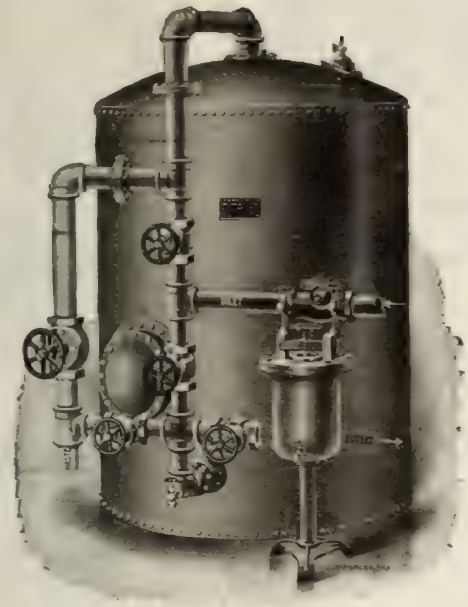
MADE IN SEVEN STYLES AND SIZES



Roberts Water Filters are in extensive use in residences, apartment houses, hotels, hospitals, mills, factories, and various institutions. Vertical Pressure Filters are made in seven styles and sizes ranging from 12 inches to 96 inches in diameter. Built also in horizontal and gravity type for municipal purposes.

Style H Pressure Filter made in sizes from 30 to 60 inches diameter, for swimming pools and industrial requirements.

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The Arthur S. Leitch Co.
Limited

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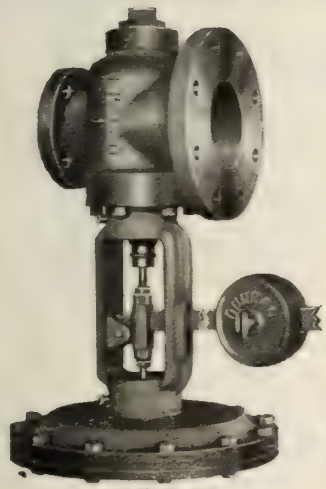
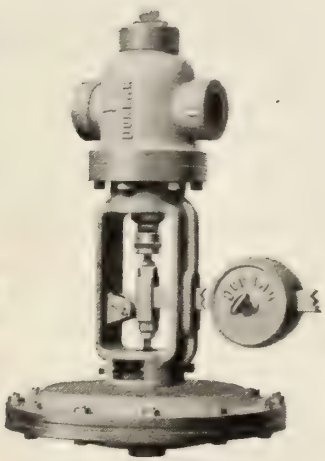


TYPE 310
(This valve has increased outlet.)



Type 300

The DUNHAM
REG. TRADE-MARK
HEATING SERVICE
(Made in Canada)

DUNHAM REDUCING PRESSURE VALVES

The Dunham Line of Reducing Pressure Valves is the result of many years' experience in the manufacture of steam-handling specialties. They are worthy additions to the Dunham Line.

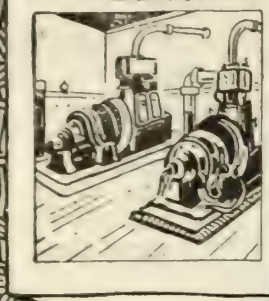
Dunham Reducing Pressure Valves are applicable to a wide range of initial pressures of steam, air, water, etc. They will reduce to the desired low pressure in one step, without chattering and are very sensitive in meeting sudden demands. The low pressure is evenly maintained, even though there be considerable variation on the high pressure side of the valve.

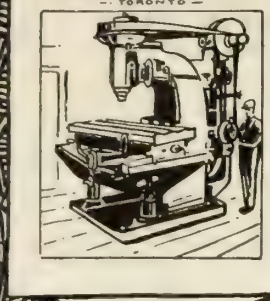
Regulation is by a lever and weight which may be set at any low pressure. Each instrument has a double balanced inner valve and seats of special phosphor bronze.

Full particulars will be sent upon request

C. A. DUNHAM CO., Limited, Toronto, Ont.

Halifax Vancouver Winnipeg Ottawa Montreal Calgary London, 18 St. Thomas Street, S.E. 1





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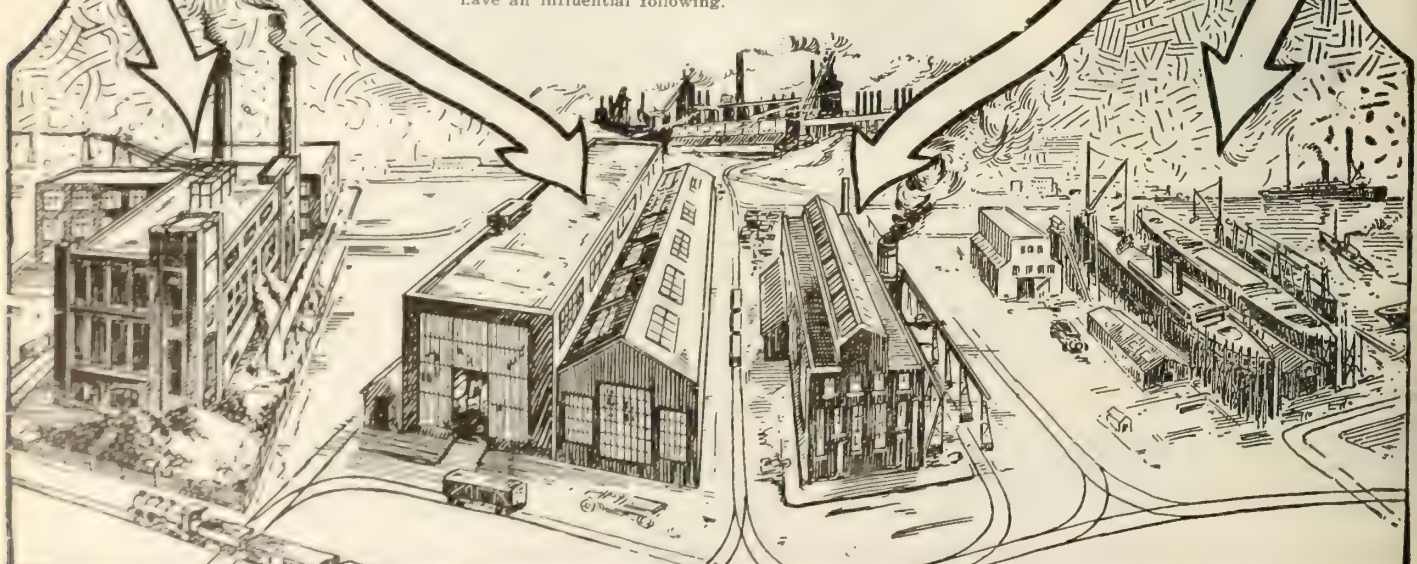

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Give your firemen a chance. A glance tells them whether everything is as it should be. They know that when the blue Air Flow record is above the red Steam Flow record that excess air is present. Everything is clear and easily understood; they cannot possibly go wrong in the adjustment of their fires under the simple and accurate guidance given by the Bailey Boiler Meter.

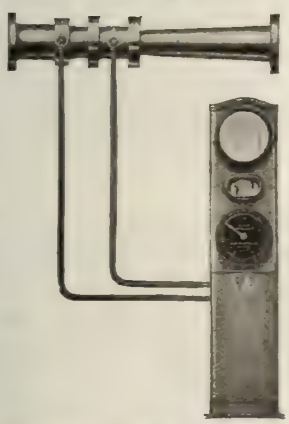
The effect of every stoker or damper adjustment is recorded on the chart for later consultation and guidance. That is why plants equipped with Bailey Boiler Meters are saving coal.

Write for Bulletin No. 42

Bailey Meter Company Limited
177 Delorimier Avenue - Montreal, Que.

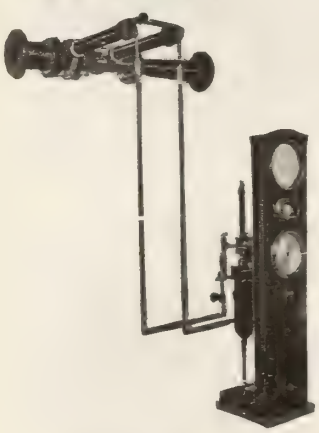
Bailey Boiler Meter
Type D-25—Class 56

THE VENTURI METER WILL TELL YOU



Venturi Boiler Feed Water Meter

1. How many pounds of water are evaporated for each pound of coal burned.
2. Which boilers are efficient and which need cleaning or repairs.
3. When a boiler can be cut out or another boiler should be put in service.
4. Whether or not the water tender is doing his work well.
5. Which kind and grade of coal is most economical for your boiler plant to use.
6. How much steam is used in the engine room.
7. How much steam is used for manufacturing processes.
8. How much steam is supplied for heating.
9. How much condensation is returned to the boilers.
10. How much circulating water is used by the condensers.



Venturi Steam Meter

Is not knowledge of these things vital for efficient power plant operation? The Venturi Meter is giving this information every day in thousands of power plants throughout the United States and Canada. Our accumulated experience in this field is at your disposal. Shall we send you further details?

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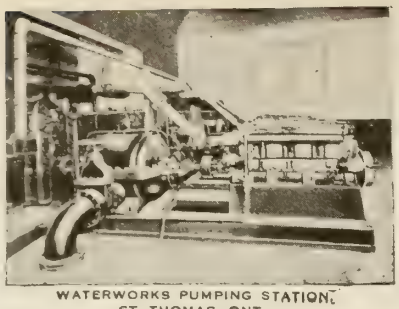
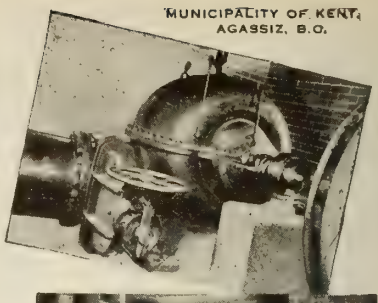

WATERWORKS PUMPING STATION, ST. THOMAS, ONT.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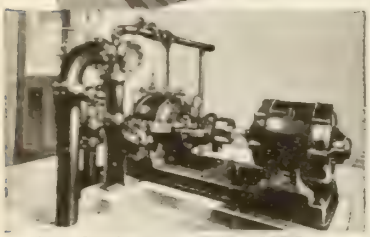
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REES RoTURBo CENTRIFUGAL PUMPS

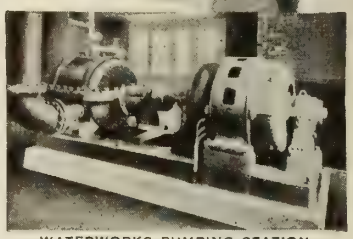
REES RoTURBo single and Multi-stage centrifugal Pumps give high and permanent efficiency over a wide range of duties and being self-regulating insure the prime mover against overloading.

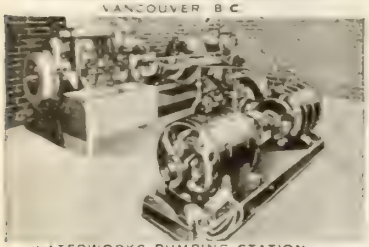
The low water velocity through all passages results in almost complete freedom from wear, even when pumping gritty water.

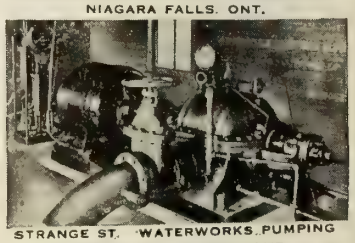
Owing to these and other important features more than 200 Rees Pumps have been installed in Canada during the last 3 years.

A few of them are shown herewith.

Catalog and complete details promptly furnished.


WATERWORKS PUMPING STATION, NIAGARA FALLS, ONT.


WATERWORKS PUMPING STATION, WATFORD, ONT.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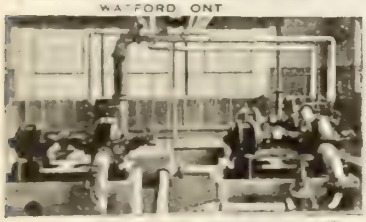
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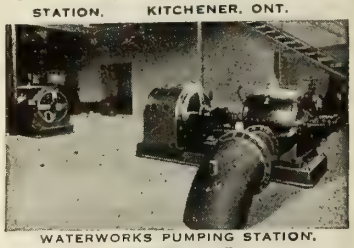
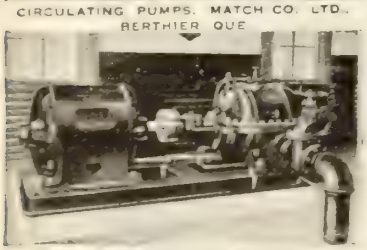
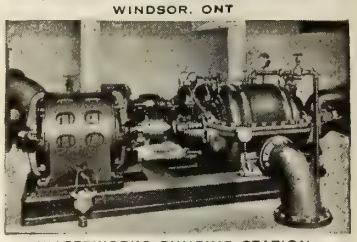

WATERWORKS PUMPING STATION, WINDSOR, ONT.


WATERWORKS PUMPING STATION, WATERLOO, ONT.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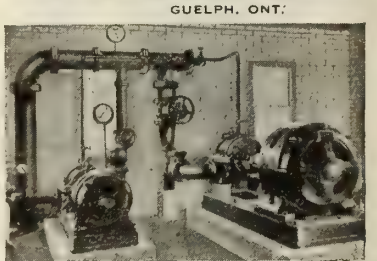
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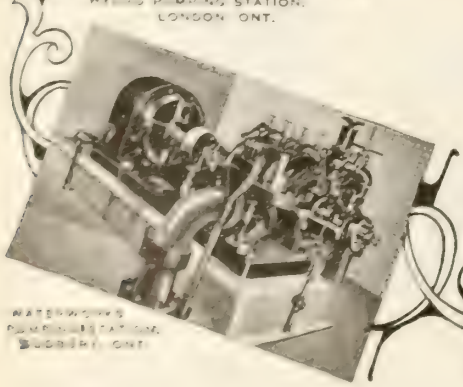
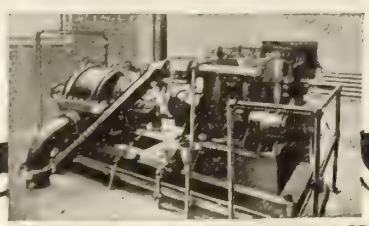
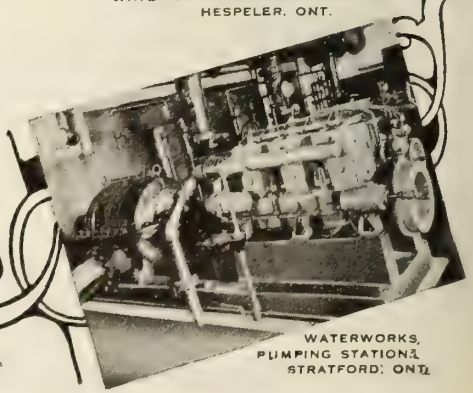

WATERWORKS PUMPING STATION, SUDBURY, ONT.


ONE OF TWO PUMPS, WATERWORKS PUMPING STATION, PRESTON, ONT.


WATERWORKS PUMPING STATION, STRATFORD, ONT.

POWER HOUSE

Members of the Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

The Cause of Clinkers in Hand Firing

One of the Most Troublesome Things Found in Hand-firing Practice is the Clinker—This Article Tells How the Formation of Clinker May be Prevented by Proper Methods

By M. BARRY WATSON

Director of Engineering, Toronto Central Technical School

CLINKERS may form over the whole grate area under a boiler forming an effective air stop, which must be broken up in order to let sufficient air through to the fires, and must be removed at the first opportunity; or they may be more noticeable as "growing" to the walls of the setting.

The most noticeable effect of clinkers is that they restrict the free flow of air through the fire, and by thus cutting down the amount of fuel that can be burned on the grate they reduce the boiler capacity. They have other evil effects such as the burning away of the grate bars and the disintegration of the brickwork.

Engineers and firemen in charge of hand fired boilers are generally more concerned with clinker formation than those having automatic or mechanical stokers under their care; although the behaviour of fires in the case of a sprinkling type of stoker is somewhat akin to conditions under hand firing. In practically all types of mechanical stokers that are self cleaning, clinkers are formed, but are of little trouble, because the constant agitation of the grates or fuel bed keeps them broken up so that the air can pass through. In the Murphy furnace there is a clinker grinder provided to break up clinkers that form and pass them through with the smaller ashes. In the travelling grate type of stoker, if clinkers form badly, the chain grate may be slackened off sufficiently that it travels over its supporting rolls in a snake-like motion, allowing the clinkers to break of their own weight as their points of support change, and allowing plenty of air to pass through, the clinkers being finally disposed of by being carried over the rear end of the grate to the ash pit or the dumping plate. In the travelling grate type of stoker, however, trouble may be experienced by clinkers growing to the side walls of the setting. In the various underfeed types of stokers the agitation of the fuel bed by the grates or push rods, etc., keeps the clinkers broken up until they roll down to the sides or back of the fire where they are removed either by hand, by a dump-plate or a clinker grinder. In most of these types there is little trouble with clinkers "growing" to the side walls.

Certain kinds of coal can not be burned under any conditions without the formation of large quantities of clinkers on account of certain fusible impurities contained in or mixed with the coal which melt when heated, and on cooling form a hard slag or clinker which seems to combine with the material of the grate bars, etc., in some cases and becoming almost impossible to remove. Fortunately, however, such kinds of coal are uncommon, and the average run of coal can under certain conditions be fired with but little trouble from clinkers.

Clinkers can be formed in burning any kind of coal under certain conditions, which conditions are more or less known to most engineers. The clinker is composed of ash which when released from its combination with combustible matter is raised to a temperature sufficiently high to melt it or at least to make it soft and sticky. Most of the ash formed is in this condition when first liberated. If this ash upon formation drops down near the grate where it is cooled by the incoming air it solidifies in small particles and most of it falls through the grate to the ash pit. If on the other hand it falls from one to another of the layers of burning fuel beneath it, it will gather up more and more of this soft sticky ash forming large clinkers or even forming a more or less continuous blanket somewhat above the grate. As soon as the greater part of the combustible matter is burned away from beneath it, this mass will solidify, preventing the free flow of air to the fuel above. This blanket must be broken up and the pieces removed when possible, making more work for the fireman.

The walls of a furnace are always somewhat cooler than the burning fuel. Thus if any of this molten or sticky ash comes in contact with these walls it at once sticks and solidifies. This small layer of clinker now acts as the wall and collects more and more of the sticky ash, until large clinkers have "grown" to the side and bridge walls. These clinkers may extend several inches from the walls over the grate, effectively shutting off the air supply that should come through the part of the grate covered. Thus the effective size of the grate and the power capacity of the boiler are reduced to a very appreciable extent. These clinkers are sometimes so hard and stick so tightly to the walls that the brickwork is damaged in dislodging them. It is generally found that these clinkers "grow" to the walls between about three and ten inches above the grates depending on the thickness of the fire. They seldom, however, extend closer than three inches to the grate.

It would appear from the above that to prevent the formation of clinkers we must attack the trouble at its source and endeavor to prevent the ash as it forms from coming in contact with other particles of ash, or the walls of the setting, until it has become sufficiently cool that it is no longer sticky. There are, however, other condititions which can help or hinder the formation of clinkers, such as the temperature of the fire at the point of ash formation and the composition of the furnace gases at that point.

Fusing Point of Ash

It has been found by Mr. Kreisinger* and others that the temperature of the fuel under hand fired boilers varies between 1,800 and 2,700 degrees Fahrenheit.

With low rates of combustion, i. e. 20 to 30 lbs. coal per square foot of grate surface per hour, the temperature of the fire is highest at about 2 to 4 inches above the grate, where it is around 2,400 deg. F., while it is as low as 1,800 at 7 to 10 inches above the grate depending on the thickness of the fire.

With high combustion rates, i. e. 100 to 125 lbs. coal per sq. ft. grate per hour,

*U. S. Bureau of Mines, Technical Paper No. 137.

the high temperature of about 2,600 to 2,700 deg. F., is maintained from about 4 to 8 inches above the grate.

Messrs. Fieldner and Hall of the United States Bureau of Mines have found by experiment that the melting point of ash from ordinary soft coal, apart from being dependent on its own chemical composition, varies according to the kind of atmosphere in which it is heated. †

The general conclusions reached from the result of the above mentioned experiments and tests are that when ash is heated in an atmosphere containing plenty of free oxygen, its melting point varies with the composition of the coal from about 2,500 to 2,650 deg. F., whereas if heated in a reducing atmosphere or atmosphere lacking in free oxygen, the melting point averages about 100 degrees lower than the above.

From a consideration of the temperatures of fires and the melting points of ash as found above, it would appear that with low rates of combustion, where the temperature of the fire is little, if any, over 2,400 deg. F., there would be little trouble experienced with clinkers. This conclusion is borne out in practice, as everyone knows that very few clinkers form when very light fires are being carried.

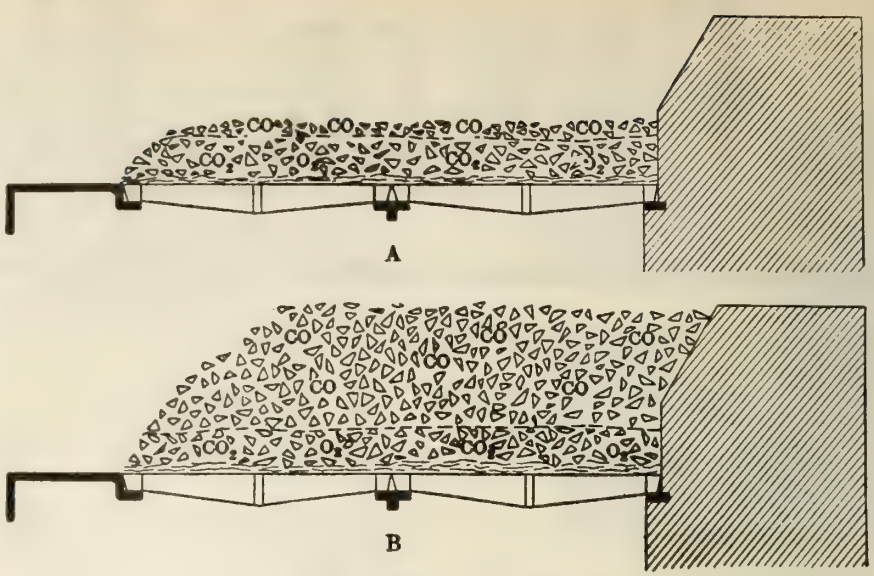
With high rates of combustion, the lower three or four inches of the fuel bed are apparently kept cooler than that above by the rush of cold air entering through the grates. This explains the tendency for clinkers on the side walls not to form close to the grate. Above the three or four inch level the temperature of the fire is probably higher than the melting point of the ash, and with thick fires this plastic ash collects in large sized clinkers before it gets down to the cooler layers. With thin fires, say [illegible] inch, most of the ash is formed in the lower layers of the fire because only the gases and oils are being distilled off and burned during the time that the fresh fuel is on the top of the fire, therefore most of the ash will drop off from the lumps of coke in the cooler layer of the fire and little trouble will occur from clinker formation.

With medium combustion rates it is likely that the fire temperature is just around the melting point of the ash, and it is under these conditions that it is of importance to so control the quality of the gases in the fire that the ash will have as high melting point as possible, so it will be less likely to fuse into large clinkers.

Thick Fires a Menace

Thick fires are a more troublesome source of clinkering than all other causes combined. In the case of a fire only three to five inches thick, the flow of air keeps the grate bars and the lower layers of the fire, where most of the ash is separated out from the coal, comparatively cool so that the ash remains in small particles and easily falls through the grates. If a thick fuel bed is maintained the resistance to the flow of air is increased and much less air passes through the fuel bed, necessitating the admission of more air above the fire to ensure good combustion, thus the grate bars and the lower layers of the fire are not kept as cool as with a thin fire, and may rise high enough that practically all the ash formed will collect in large clinkers instead of dropping through the grate bars. Secondly, in the case of thick fires, the ashes which form several inches above the grate, which they are bound to do because the fire is so thick, can not fall to the cool layers of burning fuel, where they gather more sticky ash and eventually form large masses which form solid clinkers upon reaching the cooler layers near the grate. Thirdly on account of the smaller quantity of air passing through a thick fire, all the oxygen is burned out of the air in the first few inches of the fire bed and above that we find a reducing atmosphere, which as has been shown previously lowers the melting point of the ashes, tending to form more clinkers than would be otherwise formed at medium fire temperatures.

† U. S. Bureau of Mines Technical Paper No. 80.



Two Conditions of Fire Bed.

In order to illustrate the above conditions, the following extract is taken from the United States Bureau of Mines, Technical Paper No. 80.

"Suppose that in two boilers, A and B, exactly similar in design and size, coal is burned at the same rate, the total air supply being 17 pounds per pound of carbon in the coal, but in boiler A the fuel bed is 5 inches thick and in boiler B 10 inches thick. The low resistance of the 5 inch fuel bed in A permits about 12.2 pounds of the 17 pounds of air used to burn one pound of carbon to enter through the grate, and only 4.8 pounds are admitted over the fuel bed. On the other hand, the high resistance of the 10 inch fuel bed in B allows only 7.9 pounds of air to enter through the grate, so that 9.1 pounds must be introduced over the fuel bed.

"The compositions of the gases rising from the fuel beds in the two furnaces are about as follows:

Boiler No.	Carbon Dioxide (CO_2)	Oxygen (O_2)	Carbon Monoxide (CO)	Nitrogen (N_2)	Pounds of Air per Pound of Carbon
A—	13.0	3.0	6.0	81.	12.2
B—	5.0	1.0	22.0	83.	7.9

"The composition at the end of the combustion space after all of the 17 pounds of air has been introduced and combustion is completed, is about: CO_2, 14.0 per cent.; O_2, 6.0 per cent.; CO, 0 per cent.; N_2, 80 per cent.

"It is easy to see that 12.2 pounds of air flowing through the grate of boiler A absorbs more heat from the layer of ashes and thus keeps them cooler than the 7.9 pounds of air flowing through the grate boiler B. Consequently the ashes in B will become hotter than the ashes in A, and the danger of bad clinker will be greater.

"The fusion temperature of the ash is lowered by the reducing atmosphere surrounding the upper layer of ashes. In a thick fuel bed the ash becomes mixed with burning coal to a greater height than in a thin one, and at the same time, on account of the lower velocity of the gases the reducing zone is nearer the grate than in a thin fuel bed. In fact, in thin fires the reducing zone may be limited to the top inch or two of the fuel bed, where the bits of ash are comparatively few and far apart, and can not melt together even if they are heated to the fusion point. The distribution of ash and the probable oxidizing and reducing zones are illustrated in Figures A and B. The reducing zone is marked by CO; the oxidizing zone is marked by CO_2 and O_2. The particles of ash are represented by elongated dots. The line between the ashes and the burning coal is more marked in the thin fire than in the thick one.

"Two cases of clinker caused by a thick fuel bed are given below:

"At a plant containing two 250 horsepower boilers complaint was made of one or two shutdowns daily on account of clinker. The writer was sent to investigate the cause of this trouble and found on visiting the plant, at about 9 o'clock in the morning, that the fires were 12 to 16 inches thick, were badly clinkered, and the steam pressure was slowly dropping. The fireman stated that he had started his daily shift with a clean fire at about 5.30 a. m., and that the clinker had accumulated since then. It was evident that the fires could not be run until noon and a shutdown was inevitable; consequently, firing was stopped altogether. The fires were allowed to burn down as much as possible and then were thoroughly cleaned. Cleaning was difficult, as the clinker adhered to the grate, side walls and the bridge wall. It took over an hour to clean the two furnaces. After cleaning, fires about five inches thick were carried and the steam pressure was kept easily near the blowing off point until 9 p. m. without further cleanings. At this time the fires were cleaned. The refuse found on the grate consisted mostly of free pieces of ashes and was easily removed with a hoe. No slice bar was used. This plant could run easily from morning till evening without the fires being cleaned.

"At another small plant having two horizontal tubular boilers of 150 horse power each, trouble from clinker was reported. A black matter was said to run into the grate and choke the air supply. On visiting the plant the writer found that the fireman carried a very heavy fire, 14 to 18 inches thick. The fuel bed extended to the fire door, covering the deadplate completely and nearly filling the firing door opening, so that firing was difficult. The fire-door arches and lining were badly burned, and the cast iron furnace front was cracked and warped in many places, from the fire being kept inside the firing door. The molten ash was running through the grate as a black, sticky substance, which hardened below the grate and formed 'icicles.'

"The cleaning of this fire was difficult on account of the clinker being fused into the grate. After the fires were cleaned a light fuel bed about five inches was carried, and to the surprise of the fireman the load was carried on one boiler. After carrying a light fuel bed for six or seven hours the fires could be cleaned without the use of a slice bar. After the change to light fuel bed this plant had no trouble from clinker."

Don't Disturb Fires

Next to too thick fires, the most common cause of clinkering is too much stirring of the fires. Most soft coal, especially if containing much slack, will, if fired thickly, fuse into a sticky mass due to the distillation of the tar and oils contained in it, leaving an almost solid blanket of sticky coke over the fire. To remedy this condition many firemen run the slice bar under the fire and pry up on it to break the crust to let the air through. In doing this some of the ashes and small clinkers from the cooler area at the bottom of the fire are lifted into the upper and hotter parts of the fire, where, there being a reducing atmosphere, they are sure to melt forming troublesome clinkers. Ash may even be lifted in the fire bed by the careless handling of the rake with the inevitable result of more clinkers.

Burning fuel in the ash pit is another fruitful cause of clinkers, and may also cause overheating and warping of the grate bars. Of course fuel is never purposely placed in the ash pit to be burned, but it is generally the result of poor firing methods. Some firemen have tried to use the "coking and spreading" method of firing, by which the green fuel is placed on the front portion of the grate where it is coked by the heat of the rest of the fire and the setting, and then spreading it after it has become fused into large lumps of coke, over the back portion of the grates, with free-burning or non-coking coal. In the process of spreading the free-burning coal, which remains in small lumps, over the back portion of the grate, considerable quantities of this coal may drop through the grates into the ash pit. Fuel may also get into the ash pit by the fireman allowing his fire to burn in holes and trying to fill up the holes with green fuel, part of which drops through the grate. Fresh coal or coke in the ash pit will be ignited by the radiant heat of the fire above the grates and will cause a fire hot enough to make the grate bars red hot and melt any ash lying there. This of course is assisted by the incoming air being heated up by the fire under the grate and thus being unable to keep the grate bars and lower layers of ashes cool. Molten ash in this position runs into the grates shutting off the air supply, thus cutting down the oxygen and producing a reducing atmosphere at the grates making conditions worse and worse. This clinker when the grate bars are red hot seems to corrode and combine with the iron of the bars thus weakening them. At the same time the bars are likely to warp badly and soon become useless.

Attempting to regulate the rate of combustion by opening and closing the ash pit doors may at times be a fruitful source of clinkers, as well as being wasteful of fuel as far as economical combustion is concerned. If the ash pit doors are closed when the fire is hot, the flow of air to keep the grates cool is at once cut off and the lower layers of ash are fused into clinkers by the heat of the fire above. At the same time the cutting off of the air causes a reducing atmosphere on account of the supply of oxygen being lessened, which lowers the melting point of the ash so that clinkers are more likely to form.

Highly preheated air supplied to the ash pit will also tend to cause clinkering, but the preheating of air is very unusual in hand fired boilers.

The remedies for clinkers formed by any or all of the above mentioned causes or conditions may be summarized as follows:

1. Keep the fire bed thin, not over six inches at the outside.

2. Do not level the fuel bed with a rake but place more fuel on the thin spot. Above all do not disturb the fuel bed with the slice bar.

3. Fire small charges of fuel at one time. This is especially important if the coal contains much slack or contains much tarry matter, in order to prevent the formation of thick crusts which can not easily be broken through from the top by dropping the rake on it. Firing lightly and often will incidentally increase the efficiency of the furnace and will reduce the smoke escaping. This is about the only respect in which the sprinkling type of stoker is superior to hand firing.

4. Avoid burning coal in the ash pit. If holes should develop in the fire it is permissible to use the rake to spread a little burning fuel on the bare spots before covering with green fuel, but in doing so, lumps which will not drop through the grates should be used if possible. If fire in the ash pit can not be prevented in this way, keep a small quantity of water in the ash pit, the evaporation of which will absorb much of the heat and prevent the coal burning. If the ash pit will not hold water, a little exhaust steam can be fed to the ash pit with good effect.

5. Do not try to control the rate of combustion by means of the ash pit doors, but always use the chimney damper. This keeps an oxidizing atmosphere in the fire, keeps the grate cooler, as well as tending toward more efficient combustion.

If all the above precautions are taken and bad clinkering continues, a little crushed limestone, walnut size, thrown on the fire when starting from a bank, or after cleaning, will help, but it is very seldom that this will be found necessary.

BULLETINS

The A. W. Cadman Manufacturing Co., Pittsburgh, have recently issued two bulletins, entitled respectively "Bearings and Bearing Metals," and "Cadman Metals." The first named which is known as Engineering Bulletin M-2, is a semi-technical treatise on bearing metals in general, including a short history of their origin, the requirements of a successful bearing metal, and friction in bearings. Some useful charts are included, as well as illustrations. Permissible bearing pressures and the heating effect on bearings are also treated.

The bulletin on "Cadman Metals" is known as Engineering Bulletin No. 1, and follows the same general lines as the first, excepting that the metals treated are those manufactured particularly by the firm itself. It is well illustrated, micro-photographs of different kinds of metal made by the firm being shown.

Principles of Design of Air Compressors

The Conclusion of This Article, the First Part of Which Appeared in the Issue of September 5th, Deals With Turbo Compressors and Their Characteristics

By WILLIAM REAVELL
Read before the Institute of Mechanical Engineers

TURBO-compressors.—Consequently for large volumes, the turbo-compressor, in connection with which Professor Rateaus' pioneer work has already been noted by the author is coming into increasing use. The evolution of the rotary compressor has been a very rapid one, and to-day the design and construction of this type has reached a fairly recognized standard practice.

A few years ago makers regarded a peripheral velocity of the rotor of about 500 ft. per sec. as a maximum permissible limit, but the present-day tendency aims at the adoption of higher speeds, which are rendered possible by the use of modern alloy steels. Peripheral speeds of 700 to 800 ft. per sec. are now frequently met with. Such speeds produce a much higher pressure rise per stage, and consequently enable the designer to reach relatively high pressures with few stages. Whereas a little over a decade ago fifteen to twenty stages were required to produce a pressure of 100 lb. per sq. in. gauge, such as is common in colliery working, a modern turbo-compressor will produce this pressure with about half of this number of stages.

The diagram, Fig. 13, shows the relation between peripheral velocity and pressure ratio obtainable in a single-stage turbo-blower when dealing with air at normal temperature and atmospheric pressure at the inlet.

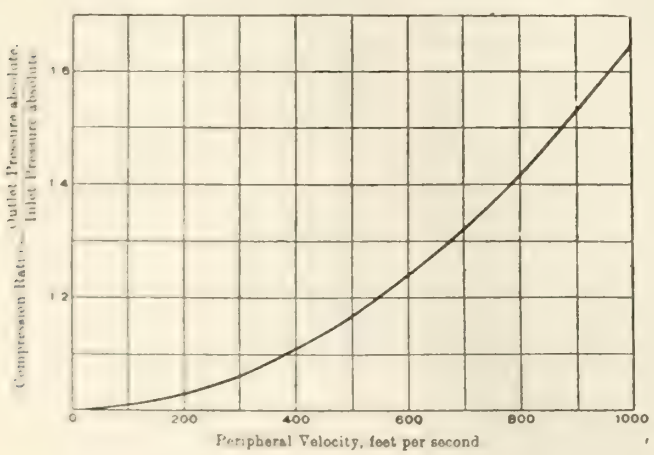


Fig. 13.

From this it will be seen that if a tip speed of 900 ft. per sec. could be used, a rise in absolute pressure of about 50 per cent. per stage could be obtained, so that in a turbo-compressor for 100 lb. gauge delivery pressure, only five to six stages would be required, provided suitable material could be obtained for the revolving discs. Doubtless the metallurgist will succeed ere long in providing the designer with a material which will comply with these conditions; in the meantime the aim is to obtain the maximum over-all efficiency with the speeds which are possible at present. To effect this, two considerations are of the utmost importance: firstly, the problem of converting the velocity energy of the air as it leaves the impeller into pressure; and, secondly, the problem of cooling the air between successive stages.

As to the first point, it will be obvious that the higher the peripheral speed of the discs, the greater will be the velocity with which the air is projected into the annular space surrounding the impeller, commonly known as the diffuser. Whilst it is possible to convert pressure into velocity by means of a well-rounded nozzle, and with an efficiency approaching unity, the converse unfortunately is more difficult. The conditions of flow are still imperfectly understood, but the following maxims must be observed if favorable results are to be obtained:—

1. The surfaces over which high-velocity air passes must be as smooth as possible.
2. The high-velocity air must be correctly guided in all directions to avoid the formation of eddies.
3. The energy conversion must take place along the shortest possible path.

In the earliest forms of turbo-compressors, the diffuser was usually bladeless; it was found, however, that the adoption of guide blades or ribs, now termed "diffuser blades," produced a higher pressure rise and also improved the efficiency. Some makers adopted cast blades integral with the casing but these were difficult to clean up; friction was excessive, and it was almost impossible to obtain the exact inlet angle for all blades as called for by the designer. To reduce the frictional effect, the spacing of the blades was rather coarse. To obtain accuracy of the inlet angle, diffusers were sometimes cast in rings separately and inserted in the stator. The latter method also allowed of polishing the guide passages, and by employing a non-ferrous alloy, closer pitching of blades and more correct form of guide passage could be obtained.

All cast forms of diffuser blades suffer, however, from the drawback of rough surfaces, which evil can only be mitigated, either by an expensive process of filing and polishing, or by providing blades of a smooth material, such as sheet brass or sheet steel, the blades being first bent to the desired shape, and then inserted in the mold and cast into a suitable ring.

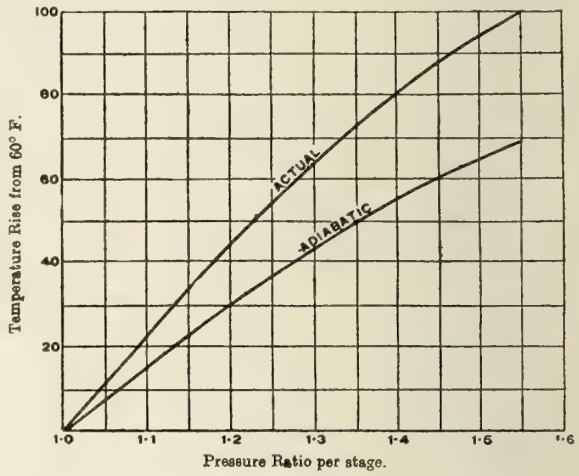


Fig. 14.

A further improvement in diffuser design has been adopted by the author's firm. The diffuser blades are made of relatively thin strips of highly polished or planished steel, or bronze, and held in place by distance-pieces which have been carefully shaped and fit into a dovetailed groove in the stator. In

this way it is possible to obtain close pitching, a very fine degree of accuracy as far as the desired inlet angle is concerned, and a means of adopting a small entrance angle, which in turn renders possible the adoption of the turbo-compressor for much smaller volumes than with the older form of diffuser. The diffuser passages are perfectly smooth, thus reducing frictional losses to a minimum; the close pitch of the blades ensures perfect guidance; the shape of the blades provides for a gradual tapering of the passage, and deflects the flow of air from a tangential into a radial direction in a very short distance. Thus the three conditions enumerated above are fulfilled in the best possible manner.

Turning now to the problem of cooling, it will be realized that the greater the pressure rise—that is, the pressure ratio—per stage, the greater will be the temperature rise. In a piston compressor the temperature at the end of the stroke will be equal to, or less than, that due to adiabatic compression; in the turbo type the maximum temperature is realized at the outlet of the diffuser blades, and generally is above the adiabatic value. This is due to the skin friction between the impeller discs and the casing walls. In consequence, the mean density of the fluid during its passage through the impeller is reduced, and this in turn adversely affects the delivery pressure as well as the energy absorbed at the compressor shaft. For these reasons it becomes imperative to employ the most thorough and efficient methods of cooling.

In the early stages of turbo-compressor construction it was possible to obtain sufficient cooling effect by water jacketing the casing. The pressure rise per stage was relatively low, the units were much smaller, and hence the amount of energy absorbed per stage, and which reappeared in the form of heat, could be abstracted with reasonable efficiency by the water-jacketed walls along which the air had to pass from stage to stage. Considering that earlier machines often had twenty or more stages to produce a pressure of 100 lb., the cooling surface obtainable in such a casing was considerable and ample.

The modern tendency of increasing the disc speed and thus effecting the total compression in a greatly reduced number of stages, clearly brings about a large temperature rise per stage. This is illustrated in the accompanying curve.

Referring to Fig. 13, and taking a peripheral speed of 800 ft. per sec., which is now possible, the obtainable pressure ratio is 1.4—that is, an increase of 40 per cent. From Fig. 14 it will be seen that the air under these conditions has a temperature rise of 80 deg. F. per stage.

In a unit designed for an output of 10,000 cub. ft. of free air per min., the energy represented by this temperature rise amounts to 350 h. p. per stage, and the equivalent heat energy must be absorbed by the cooling water if the air is to enter the next stage at the original inlet temperature. Obviously it is quite out of the question to provide sufficient cooling area for this purpose in the casing itself, and thus all makers of turbo-compressors resort to the use of intercoolers placed apart from, and usually below, the compressor casing. Considerable divergence in design is noticeable, but in principle the ultimate aim is the same—namely, to reduce the power consumption to a minimum.

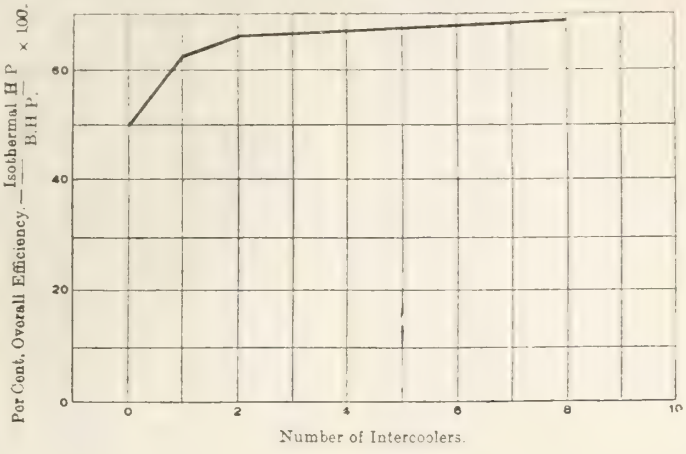


Fig. 15.

Some makers adopt a cooler after every stage; others allow the air to pass through two or three stages before it enters a cooler. The gain resulting from one or more coolers is indicated in the diagram, Fig. 15, which has been drawn for a unit of 10,000 cub. ft. of free air per minute, compressed in nine stages to a gauge pressure of 100 lb. per sq. in.

The diagram is based on the assumption that after each cooler the temperature of the air has been reduced to suction conditions. It shows that a marked gain is to be obtained by the adoption of one cooler; a further gain from two coolers, but only a slight further improvement from a cooler after each stage. This further slight gain is negatived in practice by the more tortuous path of the air, so that the best arrangement would appear to be to place a cooler after every third stage—that is, between the third and fourth, and again between the sixth and seventh. A cooler after the last stage has no effect upon the power consumption, but is adopted occasionally where cold air is desired.

The compressor casing itself need no longer be jacketed, resulting in a great simplification of this casing; further, all water joints on the casing are avoided. The intercoolers themselves are of standard design, resembling the condenser of a modern steam-turbine installation.

The tip of the blade is variously sealed against the stator by some form of packing usually leather or fibre. Where high rotational speeds are desired, this form cannot be utilised, owing to the high surface speed of slippers in their grooves. If the blade slides freely in the groove, without the use of guides and covers, its centrifugal force, and the high velocity of rubbing speed of the tip of the blade against the stator, again limit the rotational speed possible. Several methods have been used for restraining the centrifugal force of the blades to enable higher speeds to be used.

A compressor or exhauster of this type constructed by the author's firm enables high rotational speeds to be adopted by interposing between the stator and the blades a freely revolving cylinder carried on roller bearings (Fig. 12). The centrifugal force of the blades in this construction causes the freely supported cylinder to rotate, thus practically eliminating the rubbing between the tips of the blades and the stator in the old form, and, the cylinder being perforated with holes, air passes freely through the machine.

All of these types of machines, while adapted for low-pressure compressors and for exhausters, are not easily designed for high pressures, for two reasons:—

1. That the surface available for water cooling is not large compared to the volume of air passing through the machine.

2. That in all rotary machines of such general types the delivery pressure projected on the whole surface of the rotor causes a considerable total load on its bearings.

These objections have increasing force as the capacity for which the machines are designed increases.

The author hopes that the developments which have taken place in recent years in turbo-compressor design will justify the space he has devoted to this part of his subject.

He also desires to thank the various firms who have been good enough to supply him with information for the purpose of this paper.

Combustion for the Boiler Room Operator

Some Further Remarks on Draft, and Drop in Pressure Through the Brick Setting of a Boiler. Use of Draft Gauge—Combustion and the Temperature According to Theory

By T. H. FENNER

FOLLOWING on the remarks on draft in the last instalment, we will at once see that there is a necessity for some kind of gauge to show the operator the amount of intensity of the draft at any moment. Having seen that draft is measured in inches of water, which is the height of water that the difference in pressure will support, the idea of an actual water column immediately occurs. It is on this that practically every draft gauge is based, though in some cases, instead of water being used, an oil of lighter specific gravity is used. This oil lends itself more readily to showing slight fluctuations of pressure on a large scale indicator, so that a difference of .1 of an inch in draft can readily be seen by the operator.

The ordinary water column draft gauge can be very easily manufactured from an ordinary gauge glass, which can be heated and bent into the form of a U. If one end is connected to the furnace, and the other left open to the atmosphere, and the tube partially filled with water, the difference of pressure will cause an alteration of the height of the water in each leg of the U. If an ordinary wooden rule is fastened in between the two legs of the U, the difference of the water level can be read directly in inches or parts of an inch. The illustration shows this quite plainly.

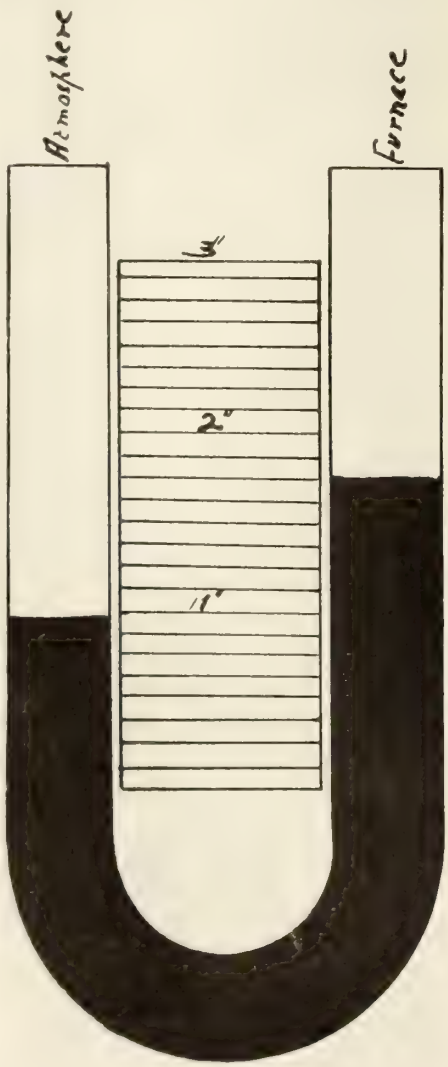
Draft gauges should always be connected in such a manner that readings can be taken from several different parts of the boiler setting, or at least three. In horizontal boilers one connection should be to the furnace, one in combustion chamber, and one in smoke box. In water tube boilers a connection to furnace, one after the first baffle, one after the second baffle, and one in last pass. Of course, this is assuming natural draft. If forced draft is used, there must be a connection to the ashpit as well, to show the amount of pressure above atmosphere existing there.

Drop Through Setting

These readings are of great assistance to the man in the boiler room, as they tell him, without the assistance of any instruments, a good deal about the condition of his brick setting. It is of great importance that the air which is used for combustion shall enter the furnace and setting only in such ways as can be properly controlled. Air infiltration through the brickwork should be rigidly excluded. Inside the setting, there should be a clear course for the gases through the path laid out for them by tubes and setting, and the friction loss should be a definite one.

For instance, suppose we have a horizontal return tube boiler, and we see by our draft gauge that the pressure over the fire is one half inch less than atmosphere, or in other words, our water gauge is showing a difference of ½ inch between the two levels. We next try the gauge at the combustion chamber, and find that difference in pressure there is .6, or 6/10ths of an inch. There has been a further drop of pressure owing to the gases having to pass over the restricted area of the bridge wall.

On trying the gauge at the breeching, we find that the difference in pressure is now .7, or 7/10ths of an inch, the loss being due to the friction of the tubes on the air in passing through.



Draught Gauge Tube.

In a water tube boiler of the horizontal type, the drop in pressure at each pass is usually about 1/10th of an inch. That is if the draft over the fire is say, .3 inches, at the first pass it will be .4 inches, at the next .4 inches, and at the last pass .5 inches. This is when conditions are normal.

Suppose now that we have in the horizontal boiler, with the same condition of fire bed, a gradual increase between the back end of the tubes and the smoke box. This will immediately denote to the attendant the presence of dirt in the tubes, which is further restricting the passage of the passes, and increasing the pressure drop. On the other hand, in the same boiler, suppose we found that between the furnace and combustion chamber we were getting no difference of pressure, what would it indicate? Generally, that the brickwork of the boiler was leaking and a sufficient volume of air was infiltrating through from the boiler room to offset the effect of the friction of the bridgewall passage. Here we have a very significant and easy pointer. When you find a greater difference of pressure between two points than is normal, look for restricted and dirty passages. When you find less difference, look for short circuiting of the gases, or infiltration of air through the setting. For instance, if in the water tube boiler, there is no drop between any two passes, it is a good indication that the baffling has fallen down, and the gases are taking a short cut from one passage to the next without going round the heating surface.

Fluctuations in the draft over the fire, with the same position of damper, warn the operator of a defect in the fire itself. For instance, if the pressure drop between ashpit and furnace suddenly increases with the damper at the same position, it is due to one or two things. First, a fresh fire has just been put on, making the fuel bed thicker, and increasing the resistance to the passage of air through it, or else the lower layer of ash, next the fire bars, is getting thicker, or perhaps has clinkered, closing off a large part of the bars. On the other hand, if the pressure difference decreases, then it is a sure sign that there are holes in the fuel bed, allowing the air to pass through too readily. Remember that air is like any other fluid or gas, in that it will always follow the path of least resistance. Therefore if there is a thin spot or a hole in the fuel bed, there will be a rush of air to that spot.

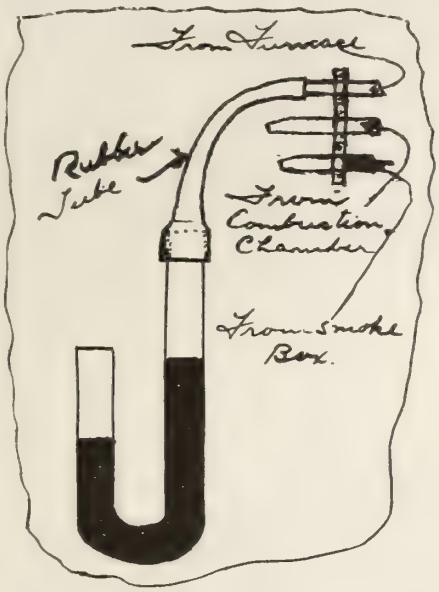
The little draft gauge then, is a pretty useful instrument, and in the small or medium size plant, where there is no other method of checking efficient combustion, it can be a great help. The first thing necessary is to instal test pipes at each of the spots where it is desired to test the draft. These pipes are all led round to the front of the boiler where the operator can see them at a glance. If he wishes to put a glass U tube on each pipe, so much the better, as then he can have every reading at a glance, but if not, he can make the rubber tube on the low pressure leg of the glass long enough to reach with ease to each pipe.

If he can purchase one of the many differential draft gauges now on the market, so much the better, as they are more reliable. The error in the home-made gauge usually comes from its position on the boiler front, where it is sometimes inclined, or the rule shifts, or the eye of the fireman or engineer is above instead of on a level with it.

Having installed the draft gauge, the next thing is to obtain some records from it which will have permanent value to the operator, or anyone that comes after him. The boiler will usually be started up with clean fires and clean tubes, (if it is a H. R. T.) on the Monday morning. Let the operator note, first with chimney damper wide open, just what the draft is at each point from furnace to breeching, with clean fires and clean tubes. Now let him close the damper down slowly, watching the surface of the fire until it becomes smoky or dull, at which point there will be practically no difference between the ashpit and pressure over the fire. The position of the damper lever or weight should be marked on the boiler wall or some convenient position when full open and when at the closed position. Now open the damper gradually until the fire looks good and bright again, and note the position and the drafts at this point. Keep the damper there, and note whether the load can be carried in that position without trouble. If so, try and carry it with the damper a little nearer the closed position. If not, open the damper slightly. Note over a period of a week the positions of the damper with different conditions of fire at which the load can be carried without undue trouble, always aiming to work with the damper closed as much as possible. Take careful notes of these results, and soon you will have very good data on the correct position of the damper for any condition of fire, tubes, and load.

The idea of keeping the damper as much closed as possible is this. In nearly every case too much air is admitted, both through the fire and over the fire, and by keeping the damper at the least possible opening for good work, this loss is cut down, and there is a certain amount of leeway left for damper adjustment as the fire thickens. With too many men, the damper is worked at its full open position irrespective of the thickness of fuel bed.

Some one of the numerous automatic damper regulators on the market are preferable to hand adjustment. Those systems which give a balanced draft, that is, that tend to keep the pressure



Flexible Draught Gauge Connection to Furnace Combustion Chamber and Smoke Box.

in the furnace the same as that of the outside air have the advantage of offering the least facility to air infiltration. These, of course, are applied to boilers working under forced draft, as under natural draft, the pressure over the fire must always be less than atmospheric.

The Process of Combustion

If we leave a piece of iron or steel to the weather, for any length of time, the oxygen of the air gradually combines with the carbon in the steel, the result being the formation of oxide of iron, which gradually flakes off and disintegrates, in the form we know of as rust. If the process is left long enough, the whole mass will disappear, having been resolved into its component parts. This process is attended with the evolution of heat, but the process is so gradual, that the heat is not apparent to the senses. It is a process of slow combustion. We have seen that it requires a definite amount of air, to burn one pound of coal or oil, or wood, and in order that this combustion may proceed rapidly, the oxygen must be mixed very thoroughly with the carbon and volatile gases of the fuel. The resulting heat is given off so quickly, that the temperature rises, and if the gases are confined in a comparatively small space, and are in direct contact with conducting surfaces, the heat will be transferred through these conducting surfaces to whatever there is on the other side. In the case of the boiler the conducting surfaces are the tubes or shell of the boiler, and the water is on the opposite side of the conducting material.

We can, with the help of the chemist, see what temperature we may expect to derive from the burning of one pound of fuel with the exact proportion of air, and after that we shall be in a position to appreciate the effects of getting a surplus quantity of air in our furnace. The temperature given by the following formula, is of course theoretical, and is never reached in practice, but it does form a guide as to possibilities. The formula is from Kent's Handbook, and is made on the assumption that the specific heat of the gases in the furnace is .237, and that the hydrogen and water content of the fuel exist in the combustion chamber as steam.

Let C equal percentage of carbon.
Let H equal the percentage of hydrogen.
Let O equal the percentage of oxygen.
Let W equal the percentage of moisture.
Let f equal lbs. of dry air per lb. of fuel.

$$\text{Then } \frac{616C + 2220H - 3270 - 44W}{f + 0.02W + 0.18H} = T$$

Suppose we had a fuel of the following composition: Carbon 78 per cent., hydrogen 5 per cent., oxygen 3 per cent., moisture 6 per cent. The weight of dry gases per lb. of fuel would be, under theoretical conditions, approximately 11.5 lbs. Applying these figures to the formula

$$T = \frac{616 \times 78 - 2220 \times 5 - 327 \times 3 - 44 \times 6}{11.5 - .02 \times 6 - .18 \times 5}$$

which come to 4831. This represents the rise of temperature of the furnace gases, if there were no losses.

In practice the temperature of the furnace ranges from 1400 deg. to 2500 deg., which is a long way from the theoretical. It will be seen that the pounds of flue gas per lb. of coal is a division in the formula, so that every increase in the air admitted per pound of fuel tends to reduce the temperature.

We can make an approximate estimate of the temperature of combustion without any elaborate formula. Suppose we have fuel of a heat value of 12,000 B. t. u. per pound. If we burn it with the minimum amount of air, say 12 lbs per lb. of fuel, we have 12,000 units available to raise the temperature of 12 lbs. air. The specific heat of air is .24 so that each B. t. u. will raise roughly 4 lbs. air 1 degree. That is, 12,000 B. t. u. will raise 48,000 lbs. air 1 degree, or will raise 1 lb. 48,000 degrees It will then raise 12 lbs.

$$\frac{48000}{12} = 4000 \text{ deg.}$$

if there are no losses.

Now, if we use, instead of 12 lbs. air, 24 lbs., which is 100 per cent. excess we bring our temperature down to $\frac{48000}{24} =$

2,000 deg. Here we see at once the effect of excess air.

Composition of Flue Gases

We can now consider the composition of the products of combustion, or flue gases, and the effect of different combinations, and what can be learned from an analysis of the gases.

The process of combustion is a chemical one, as we have seen, but in order to get a sufficiently rapid combustion, we have to aid it with some mechanical effort. That is, in starting a fire, we in the first place, supply heat by means of friction to some chemical, which is in contact with the air, this heat being sufficient to cause ignition, after which the air supports the combustion until the material is entirely changed. This somewhat lengthy explanation may be reduced to the fact that we strike a match. We then apply the flame of our match to some material such as paper, excelsior, or waste soaked in oil, which has the property of rapid combustion owing to both its composition, and the fact that it is loose in structure, and affords ample opportunity for the mixture of air. This in turn ignites with a rapid rise of temperature, and this temperature is sufficient to liberate the volatile matter in a small quantity of coal in contact with the flame. This volatile matter, on coming into contact with the air and the flame from the paper, combines with the oxygen, developing heat, and igniting in occasional puffs of flame. At this stage, however, there is more smoke than flame, showing that the temperature is not yet high enough for rapid combustion, and that the volatile matter is escaping without being consumed, and is carrying heat with it. Gradually however the temperature increases, and the gases ignite, while the solid carbon also begins to glow, and more coal can be added, until the fire is thoroughly built up and the temperature has reached the point of finality. It is at this stage that we can make our real study of the combustion, and determine whether the results we are getting are good or bad.

(To be continued)

TORONTO TECHNICAL EVENING CLASSES

The evening classes in connection with the Toronto Technical Schools open for the 1922-23 session on October 2nd. The classes for engineers will be carried on as usual, there being two classes, one for first year students, and one for second year. The first year classes are designed for those who wish to obtain elementary knowledge in connection with steam engineering, and especially for those who are intending sitting for the third class examinations of the Ontario Board of Examiners. These classes will be held at the Central Technical School, Harbord Street, on Monday and Thursday evenings, commencing at 7.45 p. m., and will be under the direction of Mr. M. B. Watson, Director of Engineering, Toronto Technical Schools.

The classes for the second year students, which are of a more advanced nature, and intended for those who wish to obtain the second class certificate of the Ontario Board of Examiners, will be held on Tuesday and Friday evenings, the teacher being Mr. T. H. Fenner, editor of "Power House." The classes will commence at 7.45 p.m. each evening.

Students in these classes are expected to pay a fee on entering, which will be returned to them at the end of the season if they have attended 85 per cent. of the classes. Full information as to registration, etc., can be obtained from the Registrar's office, Central Technical School, Harbord Street.

Don't forget classes start October 2nd.

PREPARING FOR CONVENTION

On Monday evening, September 11th, a meeting was held at the residence of Mr. C. B. Turner, 894 Bathurst Street, Toronto, of the joint committee of the Supplymen's Association, and the C. A. S. E. The object of the meeting was to complete preliminary arrangements for the 1923 convention, which is to be held in Toronto on June 25 to 28, 1923. There were present C. B. Turner, Gordon Keith, of "Canadian Manufacturer," H. H. Gee of the Jenkins Valve Co., L. M. Archibald, of the Dart Union Co., H. Fletcher of the Garlock Packing Co., representing the Supplymen's Association; and Mr. G. A. Brown, secretary Toronto branch, J. Quinlan, R. McLaren, and G. J. Soucy, representing the C.A.S.E.

The questions discussed were those of sites and buildings suitable for holding the convention, and ways and means of ensuring its success. Committees were appointed to deal with these features, and report to the next joint conference which will be held on October 10th next.

C. A. S. E. EDUCATIONAL WORK

First List of Questions on Fuels, Coal, Wood and Refuse

(1) What is the heat-value of the different kinds of coal as mined?

(2) What are the causes of loss of heat value between the mine and the time of its actual burning?

(3) What is the average heat value of fuel-oil and what relation has specific gravity to variations in heating value?

(4) How would you compare the heat value of a ton of bituminous coal (13,500 B. t. u.) at $8.50 per ton with a barrel of fuel-oil (18,000 B. t. u.) at 10c. per gal. (Imp.)

(5) What is the average heat of a pound of soft and of hard wood?

(6) Compare coal of 12,500 B. t. u. at $7.50 per ton with a cord of hard wood at $9.00 per cord and show which has the best heat value.

(7) What is the average moisture content of the different kinds of refuse burned in saw-mills and tanneries?

(8) What effect has the high moisture content with regard to its heating value?

(9) What are the two principal causes of fuel loss common to all kinds of fuel and all types of boiler?

(10) What other causes are there of fuel losses—(a) as regards the furnace (b) as regards the boiler?

General Educational Committee of the C. A. S. E.: Geo. J. Soucy, chairman and acting secretary; T. H. Fenner, (Editor of Power House) publicity; E. C. Hanson, (Power-Engineer) Questions.

Any engineers who wish to take advantage of the educational work of the association, who are in a district where there is no branch, should communicate with the grand secretary, Mr. L. J. Ellis, Hamilton.

TORONTO BRANCH C. A. S. E.

"Power House" is in receipt of the following letter from the Toronto No. 1 Branch of the C. A. S. E. through the secretary, Mr. Geo. A. Brown:—

I am instructed by Toronto No. 1 C. A. S. E. to thank you for the donations of two subscriptions to the Power House, and the two steel rules in leather cases, as prizes for our recent Grand Annual Picnic, as an appreciation of your very kind interest in our purposes.

(Signed) GEO. A. BROWN,
Secretary.

A COMPACT PORTABLE PUMP

There was recently despatched to the Far East a portable pumping set specially designed to work in very constricted spaces. This pump carries a seven horse-power paraffin engine; but it is so designed and mounted that it can be readily accommodated in a space 4 ft. long and 5 ft. high. The pump is capable of delivering 250 gallons per minute against a height of 30 ft. Water-cooling is provided, and in the event of the water available being dirty or otherwise unsuitable for cooling purposes, a radiator or fan can be brought into operation. With a view to easy transport the pump and engine are mounted on a frame with wheels, and the whole arrangement can be easily hoisted in a crane.

VALVELESS GEARLESS ENGINE

The idea of an engine without valves or gear has been realized in Great Britain by th econstruction of an engine which in the works at least, has been given remarkably promising results. This engine has three cylinders; and except for the ports it has no valves. There is not a single gear wheel and all the usual cams, shafts, tappets and springs and even the timing gear are cut out.

Flywheel Explosions and Their Prevention

Simple and Reliable Rules for the Computation of Stresses—General Considerations Influencing Types of Wheels—Remedies Suggested for Dangerous Conditions Include Preventive Measures in Connection With Governors and Governor Drives

By E. B. TOLSTEAD

STATEMENTS have been made frequently that exploding flywheels cause more damage than exploding boilers; whether or not this statement is true, it is true that state and city regulations practically disregard fly wheels but we have boiler regulations wherever we turn. It must be only a question of time when regulations and laws will protect the lives and property against flywheel accidents, as they now protect them against other hazards.

The limiting the speeds for flywheels and pulleys of the best design have been determined theoretically and by tests, and the figures agree very well. We know that a given wheel cannot speed beyond a certain point without giving way, and the speed depends among other things upon the type of wheel.

Users of fly wheels have bought their engines and other machinery equipped with flywheels, and they have assumed that the flywheels were safe for the speeds secified. Some purchasers have gone further than this. They have treated their flywheels and pulleys as they would their automobiles and they have run them at as high speeds as conditions outside of safety would permit. They have learned that faster working machines, in many cases, increase output and they have speeded up without giving the flywheel a thought.

Nearly all factory men have heard that the belt has a limit of speed beyond which there is disadvantage in going. This has been the salvation of the pulley for it has held down the rim speeds of pulleys. It should be remembered, however, that a split cast iron pulley, or flywheel with a flanged joint carrying a belt which runs at 5,000 feet per minute is going altogether too fast. A solid cast iron pulley can run at about 6,100 feet per minute and still have a factor of safety of 10 which is the figure that should be used in pulley and flywheel work.

Unfortunately, the correct speed for the belt does not always hold down flywheel speeds. For example one might have an engine directly connected to a line shaft having pulleys, let us say 4 feet in diameter. This engine might have a flywheel 10 feet in diameter. The flywheel speed could then be in the neighborhood of 12,000 ft. per minute without overspeeding the belts.

Computation of Stresses

There are three types of wheels in common use: the flywheel with a single piece rim, the flywheel with a split rim and with a link joint, and the flywheel with a split rim and with a flange joint. The solid wheel can be used only if the diameter is less than 10 feet on account of the dificulties in construction and shipment. The link jointed wheel can be conveniently adopted only where the rim is thick and since such a rim is not frequently used for belt or rope driving, where such a drive is necessary a solid wheel or flange jointed wheel is used.

One can usually get an idea of the safety of his flywheel equipment from the rim speeds, but since the computation of the rim speed requires the multiplication of three figures, namely, the revolutions per minute, the diameter of the wheel, and the constant pi, it has been found more convenient to omit the constant pi and to think of flywheels in terms of the revolutions per minute and the diameter.

The following tabulation shows the products of the revolutions per minute and the diameter which should not be exceeded if it is desired to keep the factors of safety at 10 or above:

(a) For solid cast iron flywheels the product of the revolutions per minute and the diameter (in feet) should not exceed 1,937.

(b) For link-jointed cast iron flywheels the product of the revolutions per minute and the diameter (in feet) should not exceed 1,500.

(c) For flange-jointed cast iron flywheels the product of the revolutions per minute and the diameter (in feet) should not exceed 968.

If, in any case, it is found that the product referred to above exceeds the figures suggested for the type of wheel which is operating, a further investigation of the conditions should be made.

The diameter referred to above is not taken as the outstide diameter of the wheel but as the mean diameter of the rim.

From Marks, Kent, and similar handbooks, we may obtain formulae for centrifugal force which can be finally worked into the following:

Stress in a cast iron rim, due to centrifugal force, equals $.0002664\ (RD)^2$.

If we take the accepted figure of 10,000 lbs. per square inch as the maximum tensile stress which a cast iron rim is capable of withstanding, and use a factor of safety of 10, which means an allowable stress of 1,000 lbs. per square inch, we have:—

1,000 equals $.0002664\ (RD)^2$ or RD equals 1937.

A joint in a flywheel is like a riveted joint in a boiler, in that one cannot exceed a certain efficiency. For a flange-jointed wheel this maximum efficiency is 25%. Therefore, while we can allow a stress of 1,000 lbs. per square inch in a rim of the solid wheel, we should limit ourselves to 250 lbs. per square inch in the rim of the flange-jointed wheel. Then in this case:—

250 equals $.0002664\ (RD)^2$ or RD equals 968.

Because the efficiency of a link-joint does not exceed 60%:—

600 equals $.0002664\ (RD)^2$ or RD equals 1,500.

Now, having the speeds of several wheels at which we will have factors of safety of 10, the next question to be determined is the probable bursting speeds. Since the stress increases with the square of the speed, it follows that the wheels can operate not ten times as fast but 10 times as fast as is indicated by the figures above, before they will actually burst. The 10 is approximately 3.16, therefore, the highest speeds at which wheels are likely to be able to attain are:—

(a) Solid Wheels	6,120
(b) Link-jointed wheels	4,740
(c) Flange-jointed wheels	3,059

In order that you may know the approximate factors of safety of your wheels, the following formulae may be applied:—

For a solid wheel the factor of safety equals —

$$\frac{(1937)^2 \times 10}{(RD)^2}$$

For a link-jointed wheel the factor of safety equals—

$$\frac{(1500)^2 \times 10}{(RD)^2}$$

For a flange-jointed wheel the factor of safety equals—

$$\frac{(968)^2 \times 10}{(RD)^2}$$

As explained above, the figures given are those for wheels with the best possible design of joint.

Therefore, if you make a computation from any of the formulae used above you may be sure that your wheel is not better than the result obtained from an application of the formulae but that it is less good if the design is not of the best.

The engineer who is called upon to investigate a fly wheel, finds it necessary to measure the wheel very carefully and

* Read before the National Safety Council, Detroit.

to make practically a duplicate of the original fly wheel drawing. From this he determines the stresses in the various parts of the wheel. Link-jointed wheels and flange-jointed wheels furnish complicated mathematical problems for him. A few assumptions are necessary. Most of these happen to fall on the side which would indicate the fly wheel to be safer than it is, so that when the engineer has made his computation he can only say to you "I know that the stresses are this high and I do not know how much higher they may be. Similarly I know that the factor of safety is not above this figure."

One assumption which is frequently taken exception to but which, nevertheless, is justified, seems to fall on the side of indicating the wheel less safe than it actually is. This assumption is to the effect that the fly wheel is a ring revolving in space. In other words, it assumes that the spokes do not tend to hold the wheel together. While there are undoubtedly wheels which are partially held in place by the spokes, there have been enough cases proven of actual compression against the spokes to justify those who calculate wheels in considering that the spokes at least, do not help to hold the rim together.

If the engineer could watch the erection of the flywheel and could make a record of the conditions existing as the flywheel goes into place, much that he later questioned could be answered. I have in mind a corporation in Chicago which erected a power house and put in a number of reciprocating engines. Link-jointed flywheels were used since the engines were direct connected to generators and since belts and ropes were unnecessary. When the last link was cooling down, after it had been shrunk in place, it broke. This made the company which had bought the wheel suspicious and they drilled a small hole in each of the other links. Although the link was several inches wide and the hole was probably only ¼ in. in diameter, the removal of this small amount of material was of sufficient importance so that several other of the links broke. The reason for the breakage was that the links had been made too short in the first place. Consequently, it had been necessary to heat them very hot and as they cooled to the room temperature the stress put in them was too great. It exceeded the strength of the link in only one case but had the other wheels been run up to speed it is quite possible that all of them would have broken. Had the erecting engineer carefully measured the link itself and the place where it was to be fitted, he would have been able to have determined the stress that would have been put in the link after it had cooled, or had the company's engineer noted the high temperature to which the links had been heated, he would have known that there was something wrong in the de-

Any company which has important wheels to set up should assure itself that matters of this kind are not overlooked, since it is practically impossible to determine conditions after erection without tearing the wheel down.

Causes of Flywheel Accidents

While the principal cause of fly wheel accidents comes from overspeeding, which may be normal or momentary, there are many contributing causes and several independent ones. The principal divisions are overspeeding, overloading, and failures due mainly to defects, flaws, and improper handling. The causes of overspeeding may be divided and subdivided as follows:

(a) Normally high speed not necessarily exceeded when wheel breaks. (Failure due to this cause is frequently in combination with "a" "b" or "c" under next heading.

(b) Breaking of engine parts.

(c) Breaking of engine belt.

(d) Engine belt running off flywheel.

(e) Breaking of governor belt.

(f) Slipping of governor belt.

(g) Governor belt running off pulley.

(h) Derangement of governor, which may be subdivided as follows:

1. Struck by flying parts.
2. Failure of governor pulley.
3. Loose or lost set screw.
4. Loose or lost key.
5. Gear or gears broken.
6. Fly ball off.
7. Parts broken or sheared off.
8. Insufficient lubrication.

(i) Derangement of governor valve gear.

(j) Loss of load (frequently when an engine speeds slightly, the first act on the part of men operating machines is to throw off these machines. This increases the likelihood of the engine speeding.)

(k) Circuit breaker blown out, burning out of armature, or electrical load otherwise dropped.

(l) Improper adjustment of engine stop, governor, or valve gear, or governor or valve gear parts blocked or otherwise made inoperative, or engine stop out of commission.

Overloading may be divided as follows:

(a) Clogging of machinery in mill.

(b) Unusual number of machines forced at same time.

(c) Careless or ignorant handling of friction clutches.

(d) Short circuit of driven electrical machinery.

(e) Sudden stoppage of engine.

Some of the miscellaneous causes of flywheel accidents may be divided as follows:

(a) Failure of wheel due to flaw.

(b) Failure of wheel due to improper material. (For instance, too high a percentage of phosphorous in a wheel is likely to make it brittle. Jobbing foundries frequently use phosphorous for small molds, which must flow readily. The effect of phosphorous in iron is to make it flow at a lower temperature than if the phosphorous were not present.)

(c) Failure of wheel due to crystallization.

(d) Failure of wheel due to internal stresses.

(e) Failure due to accidents to engine.

(f) Failure of wheel due to improper design.

(g) Failure due to dirt or foreign materials carried in rim.

(h) Failure due to holes drilled in rim.

(i) Failure due to increasing diameter by adding on to rim.

(j) Tight keys.

(k) Wheel struck by flying objects.

(l) Belt pull.

(m) Loose bearings.

Of the above causes derangement of the governor is probably the principal one, and broken belts the next most important one.

Remedies for Dangerous Conditions

Generally speaking, remedies which can be applied for the prevention of fly wheel accidents, may be found among the following:

(a) Better governors.

1. Triple rope drive instead of single belt drive for governor.
2. Governor sheaves to be keyed, and the unused portions of keyways to be filled in.
3. Governor sheaves to have suitable guards of substantial construction.
4. Safety cams on all Corliss valve gears.
5. Guards around governors.
6. Governor gearing enclosed in oil-tight covers, readily detachable for inspection.
7. Couplings, set screws, keys, bolts, etc. in moving parts countersunk.
8. Better care of governors.

(b) Better care of engine parts, belts, etc.

(c) Lower flywheel speed.

1. Two small wheels instead of one large one.

(d) Solid wheels instead of jointed wheels, or link jointed wheels instead of flange jointed ones.

(e) Steel, wood, or other wheels adapted to high speeds instead of cast iron wheels.

(f) Better design of equipment.

1. Avoidance of overload.
2. Arrangement of steam piping to avoid breakage.
3. Avoidance of materials fastened on outside of pulleys or flywheels, and avoid holes drilled in such pulleys or flywheels.
4. Locate engines and equipment so that the least possible damage will be done in case of breakage.
5. Space in flywheel pits for broken belts.
6. Signals from engine room to machine room, and vice versa.
7. Engine stops.
8. Automatic valves on boilers.
9. Bracing of dangerous wheels with tie rods.
10. Frequent operation and testing.

The Better Types of Wheels

The table shown, which is made up for 10 ft. cast iron wheels, shows the relative

balancing effect of wheels at various speeds and the factors of safety of two types of wheels, the increase of speed necessary to break the wheel, and relative elapsed times necessary to reach breaking speed. It should be understood that the balancing effect and the times necessary to reach breaking speed are relative figures only.

Ten Foot Diameter Cast Iron Wheels

		Flange Jointed Wheel			Solid Wheel		
Revolutions per Minute	Balance Effect	Factor of Safety	Increase of speed Necessary to break	Time to reach Breaking Speed	Factor of Safety	Increase of Speed Necessary to break	Time reach Breaking speed
96.87	1	10.00	2.16	1	40.00	5.32	4.33
150.00	2.41	4.16	1.04	0.84	16.62	3.08	4.18
193.74	4.00	2.50	0.58	0.67	10.00	2.16	4.00
306.00	10.01	1.00	0.00	0.00	4.00	1.00	3.33
612.00	40.00	....	....	....	1.00	0.00	0.00

Referring to the table above, the advantage of the solid wheel over the flange jointed wheel is readily understood. Take, for instance, the third line table. This assumes a 10 ft. wheel to be operated at approximately 194 revolutions per minute. The balancing effect of two wheels is naturally the same. The factor of safety of the solid wheel is four times as great as that of the flange jointed wheel. It must be increased in speed another 216% before it breaks, whereas the flange jointed wheel need be increased only 58%. While this increase is going on the engineer has six times the time to get the engine stopped that he would have with the flange jointed wheel. If, for instance, the time with the flange jointed wheel should be 10 seconds he would have a full minute to stop an engine carrying a solid wheel. Few engineers could be expected to get the steam shut off their engine in 10 seconds. Most of them could do it in a minute if they had the nerve to make the attempt.

Solid case steel wheels or built-up steel wheels are capable of running at higher speeds than cast iron wheels. Wooden wheels also may run faster than cast iron wheels, providing they are properly made. A well made wooden wheel may be run about 54% faster than the best cast iron solid wheel and a well made built-up steel wheel may be run about 88% faster than a solid cast iron wheel. Usually however, cast iron wheels, because of their lower cost, are adopted.

It is unfortunate that the subject of the hazards of fly wheels cannot be completely covered in a paper of this length. For instance it is regrettable that there has not been space to discuss the requirements which an engine stop should meet. The engine stop should be considered to be one of the best protections against the fly wheel hazard, but every care should be taken in choosing the engine stop. If, for instance, an engineer is slowing down his engine with a fair chance of getting the steam shut off before the fly wheel bursts and the engine stop takes hold of the throttle, winds his arm into it and becomes blocked with the throttle half open, then neither the stop nor the engineer can afford a fly wheel explosion. This has actually occurred.

BOOK REVIEW

The C. A. Dunham Co. have issued a booklet entitled the "Dunham Hand Book" featuring their line of heating appliances, together with some useful tables, and a glossary of heating terms. As the introduction states, "it is not to be considered as a text book, but as a hand book, a ready reference for those specifying, installing, or using the Dunham Products."

The B. F. Sturtevant Co. of Hyde Park, Boston, Mass., has just issued a new 72 page Engineering Bulletin on pneumatic collecting and conveying.

It contains 33 pages of pictures and diagrams, 17 pages of useful tables—how to find the size of fans, the suction, volume, R.P.M. and horsepower for any system, cubic feet of air handled per minute, size of pipe and ducts used, and various other valuable tables.

Data is also given on dust collecting from grinding and polishing machines, tumbling barrels, sand blast machines, coal breakers, shoe machinery and the removal of fumes, gases, etc. In addition, there are parts on the conveying of pulverized coal, fibrous materials, coffee, ashes, wool, wood chips, etc., etc. It is a most comprehensive treatise on pneumatic collecting and conveying systems.

A copy will be sent on request.

The McGraw Hill Book Company, 370 Seventh Avenue, New York, have just issued "Steam Engine Principles and Practice," edited by Terrell Croft. The contributors to the work are Messrs. H. C. Croft, A. J. Dixon, E. R. Powell and Edmund Sirosky, of the Terrell Croft Engineering Co. The book is divided into divisions, and these again are subdivided into sections, which makes reference to any particular point very easy. There are in all sixteen divisions, and over five hundred sections. The book covers everything that can be known about a steam engine from the operator's point of view, and embraces all the different types, their operation, their testing, and selection. The book is profusely illustrated. There are problems set at the end of each division, and the solutions of these problems are given at the end of the book for the student to correct himself. The price in the States is $3.50.

B. & S. THICKNESS GAUGE

The Brown and Sharpe Thickness Gauge No. 646, affords a relatively inexpensive precision tool of this type, which it is claimed, fills an important need. It contains six blades: .0015 in., .002 in., .003 in., .004 in., .006 in. and .015 in. in thickness, which can be used together or singly and give a variety of measurements up to .0315 in. These sizes have been selected by the makers as ones most frequently used, and to give a complete range of measurement. These blades are not rolled to size, but

New Thickness Gauge

are ground to the correct thickness. The gauge has been designed with an eyelet in one end so that it can be carried on a ring or hung up. It is especially useful to the motor mechanic and to automobile drivers, for it answers the requirements in many places around a car: for setting valve tappets, distributor headpoints, spark plug gaps, fitting pistons and determining the size of shims for joints or parts where there is play or looseness. The manufacturers state there is a broad range of use for this gauge.

This new tool is described in detail, in a pamphlet issued by the manufacturers.

CATALOGUE

The Canadian Ingersoll-Rand Co., of Sherbrooke, Que., have just issued a new catalogue covering their complete lines of engineering equipment. The book is prepared in a very convenient and interesting style, being subdivided into fifteen sections, fourteen of which are devoted to some particular class of product and the last portion to a general collection of tables, formulae, etc., for the service and reference of engineers. The catalogue is compiled in loose-leaf card index form, permitting the removal or addition of certain pages or sections when necessary. The book contains 230 pages held together in an expansion cover by means of brass screws. Three hundred halftone cuts are used to illustrate the various lines.

BOOKLETS

A booklet, known as circular 1579-B, containing general information and technical data for cutting micarta gears and pinions, has recently been issued by the Westinghouse Co. for distribution among gear cutters. The book contains a great amount of useful information for gear manufacturers.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field. Steam. Electricity and Refrigeration.

TORONTO, SEPTEMBER 20, 1922

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The Season Opens

FOR EVERY kind of sport there is an open and a closed season, and to those who look on the improvement of the mind, and a better knowledge of their profession, as a pleasure, there is an open season for study. During the long bright days of summer, a man's recreation time is better spent out in the open, at whatever relaxation he particularly affects, than in the poring over books. Of course, if there is a special reason to perform a certain task or pass some examination then study is the order, to the exclusion of anything else. In general, we think it is better for a man to build up his bodily health, and incidentally make his mind all the keener, while the fine weather lasts, and reserve his studies for the long winter nights, when time may hang heavy without some hobby. This open season for study may be said to last from October to April, and to those who wish to avail themselves of it there is ample opportunity. In every centre of population there is now a technical school, at which classes in practically every subject for which there is a demand are held. The fees for these classes are nominal, and in most cases are returned if a certain number of attendances are put in during the season. For the stationary engineer who wishes to gain some better knowledge of the principles of his work, these classes offer a fine opportunity. They should be well attended wherever they are held. The better the attendance, the more money will the department feel justified in spending on that particular class, and the better will be the results all round. If a man cannot attend a technical school, there are other means open to him. The Canadian Association of Stationary Engineers are making a special effort this year with their educational work, and any man who attends their meetings at any convenient branch cannot fail to derive benefit from it.

To-day is the day of the educated man, in whatever line of endeavor he makes his living. Knowledge is power, and no opportunity to acquire it should be lost. At the worst, a man can study at his own home by reading, but generally speaking, the average man can make far better progress when he has the assistance of others to compare notes, or to straighten out difficult propositions.

To every ambitious engineer, young or old, we would say, choose your method and line of study for the coming winter, and get into it with the earnest intention of sticking to it, just as soon as the last day of September has marked the passing of summer.

Central Heating Plants

ALTHOUGH the coal strikes in both the anthracite and bituminous fields are over, and coal is being produced, there still remains the menace of a tie-up in transportation facilities. Time alone will enlighten us on the real situation as regards coal for this winter.

These periodical coal shortages never seem to have any effect on the public mind, once they are over. While the inconvenience and in some cases actual hardship is present, there is much loud talk, but once the pinch is over, it is promptly forgotten.

Every one of these situations is an argument against the individual domestic heating plant and in favor of central stations There is but little question that the coal used in heating one hundred homes in the individual manner, would heat double that number if burned in a central heating plant. Apart from that economy, the central heating plant can burn any low grade coal, and does not have to be supplied with anthracite at fancy prices. It can afford to carry very much larger reserves. If one hundred homes have at the beginning of winter one thousand tons of coal in their bins, it is about the limit. One thousand tons in reserve in the central station plant would be the necessary amount to heat two hundred homes for the winter. Owing to using a much lower grade of coal, for the same amount as the householders put into their one thousand tons, the central station could secure approximately two thousand tons. So it goes, in every department. The time is coming in large centres of population, when there will be no other means of heating than the central station. It may not be in the very near future, but we are convinced that it is an absolutely assured development of our modern civilization.

Fly Wheel Precautions

EVERY reader should read with interest and attention the article in this issue, on the prevention of fly wheel explosions. Any one who has ever witnessed the bursting of a heavy flywheel, or who has been on the scene of the accident before the debris has been cleared away, carries for ever in his memory a picture of the scene. If the accident has been attended, as this kind of accident frequently is, with loss of life, or injury to limb, the picture is more deeply impressed. Those who have not actually witnessed these scenes, must have read of them on many occasions as they were reported in their technical magazines, and in the daily newspapers.

Every one who has charge of an engine which has a flywheel, should realize the enormous potential force stored up in that wheel. With normal running, this force is exerted in a beneficial manner, and serves to make things run smoothly. That same force liberated in a moment, and applied to carrying enormous masses of metal through the air at high velocity, smashing everything in their path like a high explosive shell, is a very terrible thing. The writer of this article has gone very carefully into the question of flywheel stresses, and the prevention of accident, and a careful perusal of his statements will be time well spent.

Progress in New Equipment

NEW LATERAL RETORT JONES STOKER

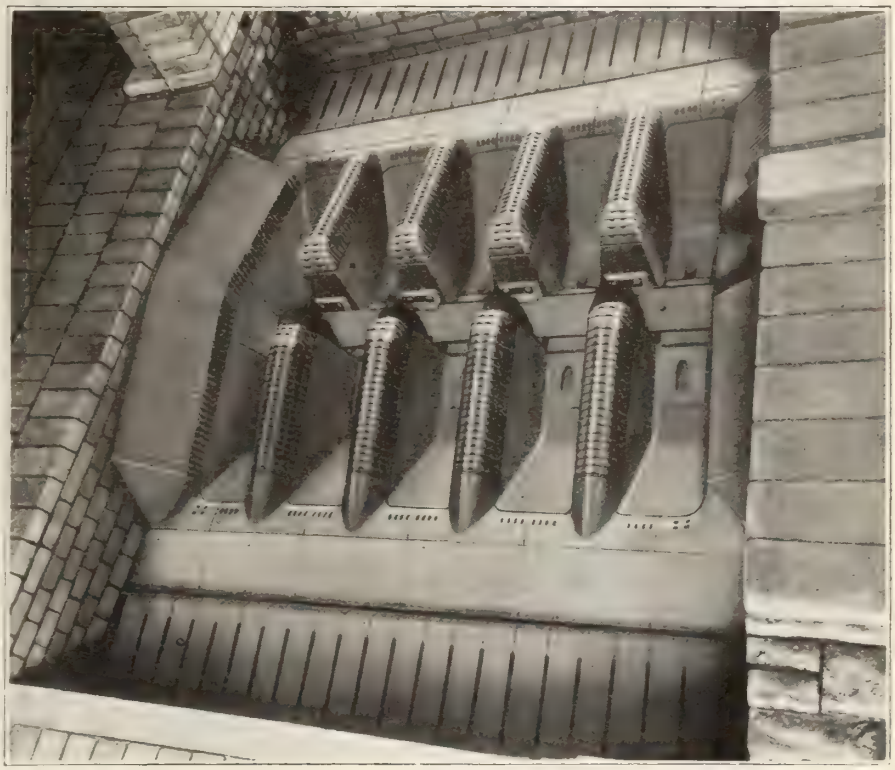
The latest product of the Under-Feed Stoker Company of Canada, Limited, is the lateral retort underfeed stoker.

The distinctive and exclusive feature of this new stoker is the fact of its being an all under-feed side cleaning equipment. The coal is fed from underneath the entire fuel bed and not, as in other side cleaning types, by a combination of under-feed and over-feed methods. This all under-feed firing provides the maximum of temperature over the whole width and depth of the grate surface.

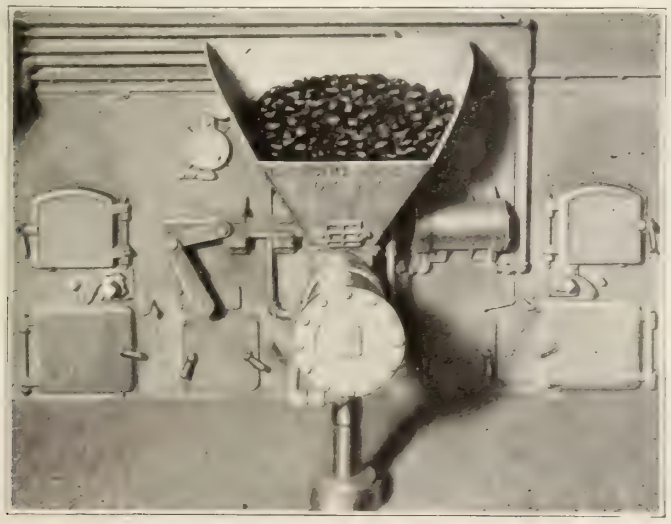
A glance at Fig. 1 illustrates clearly why this is so—note the air openings distributed over the whole surface—note the depth of retorts, which means large coal reserve.

The lateral retort stoker consists of a main retort extending from the furnace front to the bridge wall. From this main retort, at right angles, on each side, lead off four or five lateral retorts (depending on capacity of stoker).

The coal is fed in from hopper on the boiler front, see Fig. 2, by steam actuated ram, through the front wall opening on the right, Fig. 1, and is distributed front to rear by a pusher plate. Reciprocating shoes, seen in the bottom of the laterals Fig. 1, take the coal from the main retort and distribute it upwards and outwards to the dump plates at the sides. These shoes are actuated through heavy link connection by the small piston and cylinder on the right of the hopper, Fig. 2. This is independent from main cylinder, so that timing of the strokes of these shoes may be controlled independent of the main ram.



As will be seen in Fig. 1, the lateral retort stoker is of the side-cleaning type; in this respect it differs from the Jones A-C Stoker, which cleans to the rear, otherwise it is simply two Jones A-C Stokers set back to back and fed from the main retort.



The dump plates are counterbalanced and have interlocking tips on outer ends. An auxiliary supply of air may be admitted under the dump plates to provide for the burning of any particles of coal which reach them.

The lateral retort stoker is so designed as to obviate the necessity of large ash pits or basements underneath—and as it is set very low it may be installed under low-set boilers already in service without great difficulty.

If the furnace is too narrow to take the full size stoker, the half lateral may be used. This is comprised of the main retort and laterals on one side only, the main retort being set at one side of the furnace and the laterals leading off from it to the dump plate at the other side—one ash pit only being necessary.

The automatic adjustment of fuel and air is the same as with the Jones Standard and Jones A-C Stokers. The Cole automatic valves, which control the movements of the stoker pistons, are belted to the fan shaft, the fan engine being controlled by an automatic regulator which operates on variation of fuel and air is speeded up or slowed down in accordance with the steam requirements of the plant.

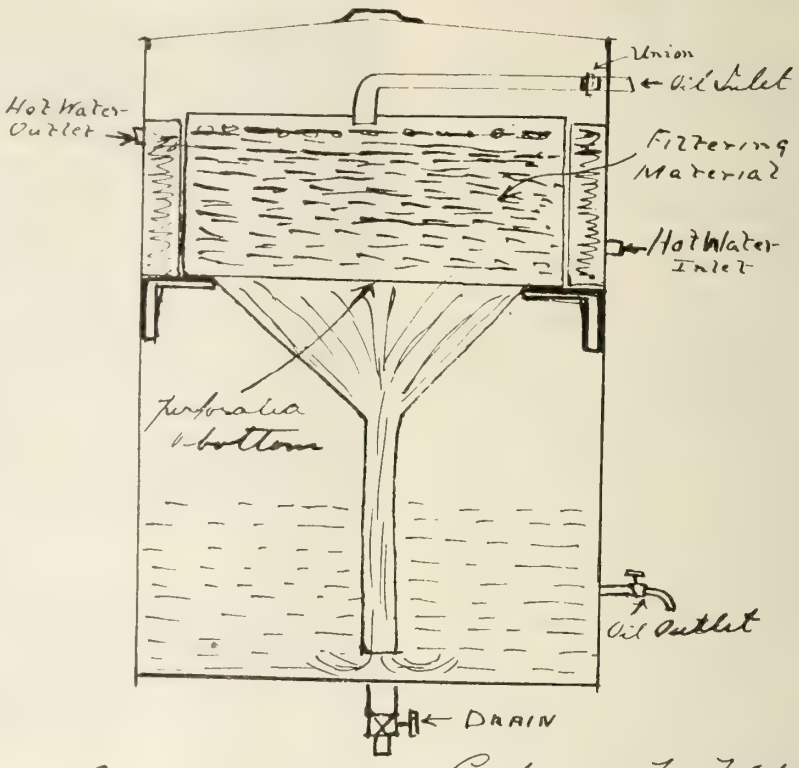
OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

OIL FILTER REQUIRED

Question:—Please tell me through the columns of "Power House" how to make an oil filter that will take the carbon and dirt out of cylinder oil that drips from the piston and crank shaft bearing of an open crank case gas engine. This oil does not contain any fuel oil such as might get into the crank case oil of a crude oil, or kerosene engine.

Answer:—There are a number of very efficient oil filters on the market, and it might be cheaper for you to buy one than to make one yourself. However, if you prefer to make one, a very serviceable one can be made from galvanized iron, in the manner shown in the accompanying sketch.



A loose cover as shown. Container for filtering material can be lifted out for cleaning. Hot water can be drawn from water jacket of engine, to keep oil in filter warm, allowing easy flow. Material can be #16 or #18 galvanized iron. Size according to quantity of oil. Filter can be set on iron stool, or on own legs, according to convenience. Charcoal, excelsior, or cheese cloth can be used for filter. Gauge glass may be fitted, but is not really necessary, and only adds to expense. A further screen can be placed at level of bottom of oil pipe if desired.

Sketch of Oil Filter.

COILS FOR COLD BOX

Question:—We have to install a box for cooling off chocolate after it is moulded. The cooling is accomplished by passing the moulds through a small room which contains refrigerating coils, the moulds being on an endless belt. There is an opening at one end in the wall of the room communicating with the hot moulding room, while at the other end there is an opening for taking the cooled moulds off the belt. The question is whether it is more efficient to use small diameter coils and a larger number to get the required heating surface, or a smaller number of coils of large diameter. Also where would be the best place to put a fan for circulating the air in the room?

Answer:—In deciding whether or not to use small diameter coils there is something else be-ide the efficiency of cooling surface to be considered. While the small diameter coils should give better intimate contact with the walls, or rather more of the gas being in intimate contact with the walls, and also because of there being a rather higher velocity than with the large diameter coils, there are other points that should not be overlooked. The space being rather restricted, the installation of smaller diameter coils with a greater number of joints, makes the possibilities of access for repair more difficult. The installation will also be more complicated, and on the whole, more costly. We should be inclined to recommend the installation of the standard type of coil for preference.

With regard to air circulation. We should be inclined to think that if the coils were installed on the roof of the building, with suitable gutters underneath to catch any moisture which falls at any time, a natural circulation would be set up. The warm air entering with the belt from the moulding room would have an upward direction, and would thus come in contact with the overhead coils, and be cooled off. It would then fall to the bottom of the room, on account of its greater density. Any moisture would be condensed on the surface of the coils, and the air would thus be dry, or comparatively so, as it descended. The constant admission of fresh warm air would tend to create a definite circulation. We should be inclined to think that a fan placed in the room would result in the cir-

(Continued on page 38)

Some Problems of Power Plant Design

SOME interesting figures were given recently by Mr. J. S. Thompson at a meeting of the Fife Mining and Engineering Society, in Scotland. It illustrates very well some of the problems connected with large steam power stations, and also indicates in which direction research is being bent to find a solution for the future.

In recent years we have heard a great deal about super-power-stations and of the necessity of scrapping all the existing stations in the country as being either obsolete or, at any rate, very inefficient. To scrap the whole of the existing power-stations in the country at one go would be sheer madness. Undoubtedly, many of these are badly situated, far from efficient, and too small to meet the demands in the districts which they supply. New power-stations will have to be erected on a much larger scale, existing stations in many cases will be extended, and some of these will in time become super-stations.

Many of the smaller stations are now seeing the advisability of purchasing power instead of installing additional plant. In such cases the existing plant may be worked up to its full capacity until the time arrives when the cost of upkeep and the inefficiency of the plant, compared with the newer and larger plant installed in the station giving the bulk supply, renders it advisable and financially sound to scrap the plant and take a complete bulk supply.

The position seems to be, therefore, that in future we shall find many existing stations not extending their generating plant, but buying in more and more of the power they require for distribution to their consumers, until in time they buy in bulk the whole of their requirements. At the same time, the more favorably situated stations will be extending their plant all the more rapidly, because in addition to having to provide for the power requirements in their present limited areas, they will be called upon to supply power for the areas supplied by the other stations gradually closing down. Alongside of this development, entirely new super-stations will be erected in favourable situations.

Hydro-electrical Plant

Considerable attention is at present being given to the matter of hydro-electric power stations, and it is quite likely that in the future a number of such stations will be constructed in this country. Provided that the capital cost can be kept down to reasonable figures, there is no question as to the advantage of making as full use as possible of the natural resources of the country, both in order to provide power as cheaply as possible and also to save the country's other great natural source of energy—viz., coal. Probably many people would be surprised to know the number of water-power plants already existing in this country. For the most part, however, these are of comparatively small power, and we may certainly expect to see a considerable advance in the use of water power on a larger scale in the near future. However, after making full allowance for the use of water-generated power, the fact remains that so far as our own country is concerned the bulk of the power will be derived from coal.

In speaking of the power requirements of the country, it is, of course, assumed that the whole of the power will in time be distributed and used in the form of electrical energy. It is, therefore, very essential that generating plant should be installed having as high a thermal efficiency as possible. In this connection it is rather disappointing that comparatively few of the existing electric power stations in the country have an efficiency of more than 10 per cent.—i.e., the heat value in electric current sent out from the works is seldom more than 10 per cent. of the heat value of the coal put under the boilers.

Prospective Saving

It is interesting to note that if all the stations had operated at the efficiency of the most efficient station—viz, 17.75 per cent.—there would have been a saving of something like 3,000,000 tons of coal. If an existing station can operate to-day at an efficiency of over 17 per cent., it is reasonable to expect that the new super-stations should show an efficiency of 20 per cent., and this alone is a very great argument in their favour, resulting, as it would, in an immense saving of coal, and consequently in reduced cost of power to the consumer.

The thermal efficiency of a power station using gas engines might be taken at 25 per cent., and had the electrical requirements of the country been much smaller, and had the steam turbine not been brought into being, there is no doubt gas engines of considerable size would have been largely used for the generation of electricity. If a gas turbine of anything from 5,000 horse-power to 25,000 horse-power, and as reliable in every way as the present-day steam turbine, could be brought out, not only would the inventor make his own fortune, but he would make it possible to do away with steam boilers, and would do much to bring about Dr. Ferranti's ideals and to bring in the era of cheap power, thereby rendering a great service to the world at large. Almost as great a boon would be conferred by devising some method of getting over the present loss in the condenser of approximately 60 per cent. of the heat value of the fuel used caused by cooling the exhaust steam and changing it back to water.

Meanwhile, we must carry on with large steam turbines as they at present exist, either burning coal direct under the boilers or treating the coal for by-product recovery and burning gas as fuel. It is possible that in the future we shall see more co-operation between gas and electricity undertakings, and it is quite likely that in power stations some boilers will be fired with coal, others with coke or a mixture of coal and coke, and others with gas.

Sites and Towers

For stations of, say, 250,000-kilowatt capacity, it will be of the utmost importance to secure suitable sites with plenty of ground available for extensions, for storage of fuel, ashes, etc., and—if carbonisation of the coal is to be a feature—for the storage and handling of the by-products. The site must be convenient for the delivery of fuel by rail, and preferably also by sea, river, or canal. Large quantities of water will be required for condensing purposes, and this is one of the essentials that will frequently be the deciding factor in fixing the site; the tendency will doubtless be to lay down the stations close to the sea, or alongside large rivers. It is not always a simple matter to lay down a large power station close to the sea; in fact, to harness the sea-water for condensing purposes is sometimes a very costly matter, and for the very large power stations we are considering, it will be no easy matter to find rivers large enough to supply the required quantity of water. If the bulk of the output of a station is required inland and remote from any large river, it will probably be found necessary to resort to cooling towers, wholly or in part, and it must be remembered that even where cooling towers are used, a very considerable amount of water will be required to make up the water lost by evaporation from the towers, in some cases as much as can be supplied from a good-sized stream.

A Typical Station

As an example, take a power station having a maximum load of 250,000 kilowatts and a load-factor of 50 per cent. The units generated per annum in this station will amount to 1,095,000,000 (fifty times the output of the Fife Power Company's station). If coal is used of a calorific value of 12,000 B. Th. U. per pound, and the station operates on a thermal efficiency of 20 per cent., the amount used per annum will be over 700,000 tons, or about 2,000 tons per day.

Allowing for only three weeks' supply of coal to be kept in reserve, storage will have to be provided for no less than 42,000 tons. The ash to be handled will be round about 200 tons per day, or 70,000 tons per annum. If carbonisation of the coal is part of the scheme, considerably more coal will have to be handled, probably 2,500 tons or so per day, or, roughly, at the rate of 100 tons per hour all the year round, or, say, 200 to 300 tons per working hour.

The quantity of water pumped into the boilers will amount to over 1,200 tons per hour. The water will be used over and over again, and allowing that 5 per cent. is required for make-up, a quantity of not less than 60 tons of pure town-supply water, or of chemically treated water will be required each hour. For condensing purposes, not less than 84,000 tons, equal to 19,000,000 gallons of water per hour, will require to be pumped from the sea through the condensers and returned to the sea, or from the river and returned at some point lower down the river; if cooling towers are used, probably a still larger quantity of water will be required to be pumped from the ponds under the towers, and, after passing through the condensers, returned to the top of the towers. In this case, to make up for the evaporation from the towers, approximately 250,000 gallons of water will be required per hour. Even to supply this will require a loch or stream of no insignificant size.

THE EFFICIENCY OF YOUR PLANT

By W. F. Schaphorst

How much of the heat in your fuel is utilized? How much is converted into work?

Nine times out of ten the burner of fuel doesn't know, and it isn't such a complex thing to solve either.

This chart will give the answer closely enough, though, and you won't have to do any figuring at all in arriving at the result. Just lay a straight edge across the chart twice and the answer is immediately found in Column E. The result may surprise you. Usually it is altogether too low.

For example, let us assume that you burn coal. The average heat value for coal is about 12,000 heat units per pound, and so we will use that figure in column A.

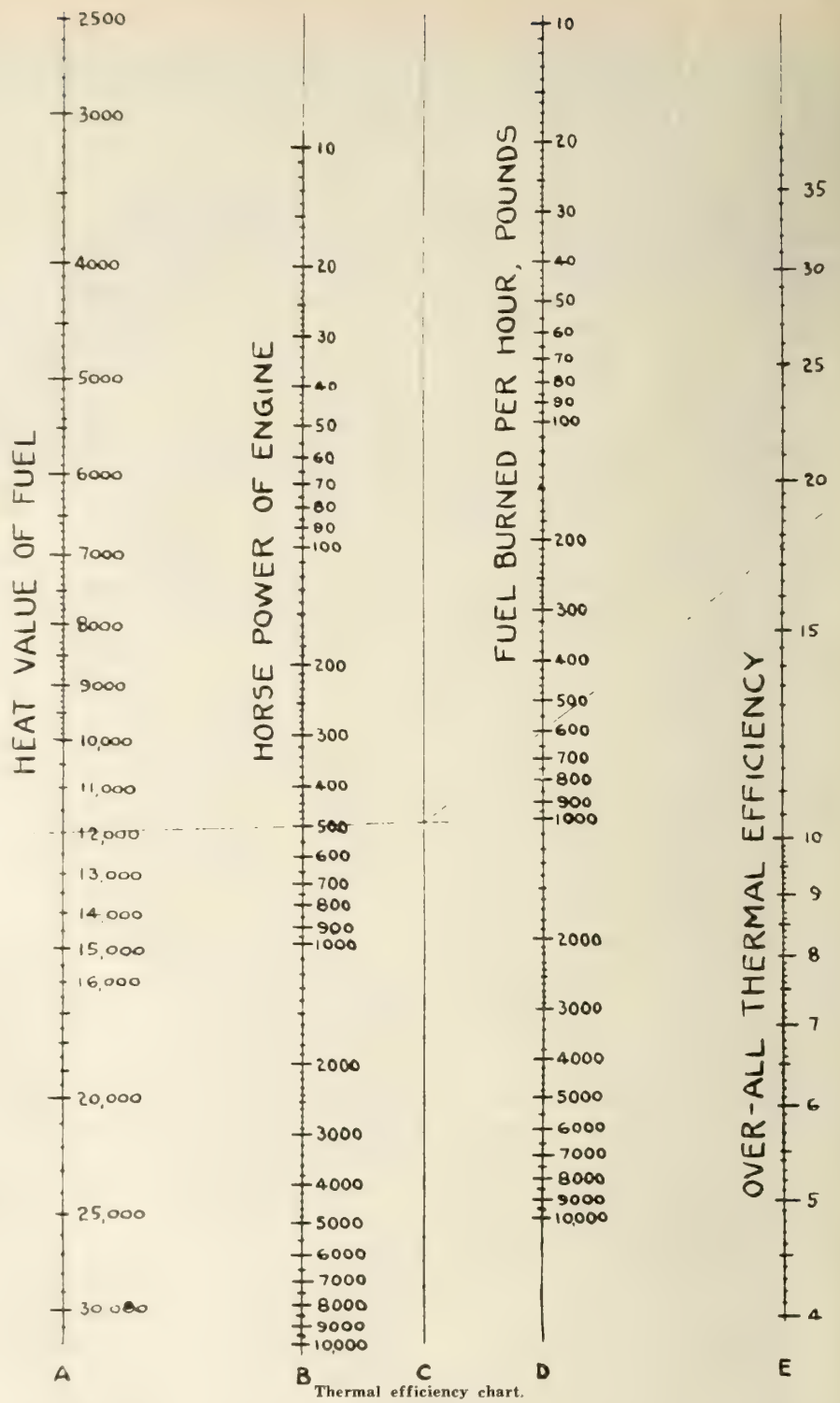
The horse power of your engine is, say, 500. See column B.

Run a straight line through these two points and locate the intersection with column C.

You burn, say, 600 pounds of coal per hour. See column D.

Run a straight line through the intersection in column C and through the 600 and the final intersection with column E gives the over-all 'thermodynamic efficiency" as it is generally called.

Therefore, in your plant, if conditions are as stated here, the performance is well above the average. Nearly 18 per cent. of the heat in the coal is converted into work. More accurately it is about 17.7 per cent.



Thermal efficiency chart.

The over-all efficiency is a thing worth knowing. If your efficiency is only 4 per cent. you should make an effort to increase it to 8 per cent. and cut your fuel bill in half. If it is 8 per cent., you should try to make it 16 per cent. and again cut the fuel bill in half. And so on.

Occasionally we find steam power plants where the thermodynamic efficiency is as high as 20 per cent., but such plants are entirely too rare. It is claimed that most plants operate at or under 4 per cent. I made 4 per cent. the minimum on this chart because such ridiculously low efficiencies should not be practised. I want to make this chart a stimulus for greater effort toward saving coal and other fuel.

The range of this chart is very wide—from 2,500 heat units per pound (green wood) to over 30,000 heat units. The heat value of fuel oils average at about 18,500 heat units per pound. Gasoline also averages at about 18,500.

Gas engines usually give higher efficiencies than steam. Efficiencies of nearly 40 per cent. are not uncommon with Diesel engines.

Practical Electricity for the Power Plant Engineer

By G. R. ARCHDEACON, A.M.I.E.E.

(Continued)

Symptom	Cause	See Remedy No.
Gravity test very unequal	Cells short circuited	1
	Plates buckled	2
	Separators broken	3
	Leaky jar	4
Momentary discharge shows low amperage.	Overdischarged.	9
Will not take charge	Cells short circuited	1
	Plates buckled	2
	Separators broken.	3
	Sulphation	5
Will not hold charge.	Slow short circuit	1a
	Leaky jar	4
	Impure electrolyte	15
Voltage comes up on charge but gravity remains low.	Leaky jar.	4
	Spillage of electrolyte	6
Gravity comes up long before voltage begins to rise.	Acid added too strong.	7
	Evaporation.	8
Electrolyte has dark color.	Shredded positives.	12
	Impure electrolyte.	15
Separators broken.	Buckled plates	2
Separators charred.	Shorted plates	1
	Overcharging.	16
Separators coated with white or bluish slime.	Impure electrolyte	15
Active material badly shrunken, positive have pinkish color.	Frozen.	14
Positives buckled, or broken at edges, active material falling away.	Overcharging	16
	Overheating (climatic)	17
	Overheating (short cir.)	1
	Impure electrolyte.	15
	Age.	13
Negatives badly shrunken and show cracks.	Age.	13
	Frozen.	14
Negative active material swollen and bulged.	Continued overcharging.	16
	Expanded from excessive heating.	18

(17) Climatic conditions cause overheating, likewise over-charging, impurities.

Overheating results in increased chemical action.

Warm weather calls for special attention to the battery, as evaporation is increased therefore pleenty of distilled water should be kept on hand for "topping up" the cells.

(18) Due to certain chemicals used in their construction, old negative plates sometimes have the active material swollen and slightly bulging from the grid.

Great care must be exercised in attempting to press back the active material, as abnormal pressure is likely to result in decreased capacity.

Negative plates in a charged condition must **Never be exposed to the air, as they rapidly oxidise resulting in such a rapid rise in temperature as to almost melt the grid.**

Care and Management of Power House Batteries

A great many people seem to think that a storage battery is something like a gas meter, and so can with advantage be stowed away in any old place, providing it is out of the way.

Happily however the "chiefs" of the large electrical power plants have now realised the necessity for a fitting location, specially designed to suit the conditions peculiar to storage battery operation.

The battery room should be lofty, well ventilated, bright. An exhaust fan should be provided to withdraw the fumes from the cells when on charge.

The floor of the battery room should consist of from 9 to 15 inches of good cement concrete. This should be covered with a thin layer of rock-mastic, or acid resisting asphalt. The level should so run that it drains into "gutters" running under each row of battery stands. The grids covering the down pipe to the drains should be made of earthenware, as the usual iron grids are soon eaten away by the acid.

The roof is preferably made of sound timber with a boarded ceiling but all the wood work must be painted with not less than three coats of anti-sulphuric paint. Never arrange a battery under a plaster ceiling as flakes of the lime wash are likely to fall into the cells, neutralising the acid, with consequent reduction of gravity, which in turn presents misleading diagnosis.

Arrangement of Cells

The cells should be arranged upon **single tier stands**, and in double rows down the length of the battery room. Do not place any cells against the walls. It is always an advantage to be able to work from both sides of a cell, in case of repairs, etc., especially if it is a large battery, whose elements may weigh anything up to 500 lbs.

If the cells are of medium size they will be in glass boxes; in such a case it is advisable to be so placed that the plates are at right angles to the length of the stands. In this position, when walking down a row, the attendant can see right through the cell between the plates.

For larger sized cells they should be contained in a hard-wood box (dovetailed not nailed). This box should be lined with not less than three pound chemically pure sheet lead. The box to be impregnated with anti-sulphuric paint.

A plentiful supply of good water should be laid on, with a tap inside the battery room, and a hose-pipe, so there is no excuse for not swilling the floor frequently and so preventing the accumulation of dust.

A sink should be fixed in one corner, for the personal convenience of the attendant, and for washing boxes, sections, elements, etc.

A first aid cupboard is most essential, with a generous supply of ammonia, linseed oil, lime water, cotton-wool, and antiseptic bandages.

A standing desk should be placed in a good light, with the manufacturers' instructions hung in front, whilst ample supply of forms, records, etc., should always be kept in the desk.

A small chest, containing portable testing set, voltmeters, hydrometers, thermometers, cell inspection lamps, graduated mixing glasses, test tubes, etc.

In the operation of the battery it is most important that either a recording-ampere-hour meter or an intergrating ampere-hour meter should be fixed in both the charging and the discharging circuits.

By such means only can you accurately ascertain the exact number of ampere-hours put into the battery, and the

number of ampere-hours taken out.

An essential instrument on the main switchboard is an automatic cut-out in the battery circuit. This is for cutting in the battery, and cutting out according to the conditions prevailing at the moment.

Never charge the battery by splitting it up into two circuits and charging both in parallel.

The dynamo for charging should always be shunt wound, as it is practically impossible for the battery voltage to run back through the exciting field of the dynamo, on account of its rising characteristic.

When the battery has been erected and about to receive its initial charge, great care must be exercised throughout this initial charge, as upon it, much will depend regarding the life and future behavior. A battery carelessly handled during its initial charge, will be ruined, and no subsequent treatment can undo the damage suffered at that time. Below are a few points to be carefully considered in connection with the initial charge.

(1) Fill up cells with electrolyte of the correct density.

(2) Fill up as quickly as possible, so that each cell is only standing in the electrolyte about a similar period of time before the current is switched on.

(3) Never interrupt the filling up, after once started.

(4) Temperature of electrolyte will increase when poured into cells. Do not start charging current until this temperature has fallen to about 75 deg. F.

(5) Go over all connections carefully. Make certain polarity of charging circuit is correct.

(6) Commence charging, at only **one half the normal charging rates.**

(7) Keep close tab on the temperature, taking readings every 30 mins.

(8) Immediately temperature exceeds 90 deg. F. reduce charging current by half. Should temperature continue to rise, stop charging entirely for about 2 hours, or until temperature has fallen down to about 75 deg. F.

(9) Take readings of specific gravity voltage, and temperature hourly for each cell.

(10) Plot voltage and specific gravity readings of one or two pilot (sample) cells. This will show up on the curve any abnormalities, and should be drawn to the attention of the manufacturer immediately. Keep these curves for reference.

(11) The initial charge may take from 72 to 95 hours of continuous charging.

(12) Somewhere within the above time limits, the gravity, and voltage readings will show themselves to be constant for a period of about 5 hours, no increase in either being indicated for such a period, voltage reading showing a constant 2.60 volts, and the sp. gravity 1.220 (or whatever working gravity is specified). Free and rapid evolution of gas from both positives and negatives. Only when such a combination appears can the battery be said to be fully charged.

One English authority says:—

"The first charge of a storage battery may be compared to the launching of a ship—it is the most momentous point in its existence."

Why the Battery Freezes

It has already been explained that the electrolyte in a storage battery is simply a mixture of sulphuric acid and water, and that the sulphur compound in the electrolyte, gradually leaves the electrolyte and impregnates the plates of the storage battery, whilst in the course of discharging, the further the battery is discharged, the more sulphur compound is abstracted from the electrolyte, leaving the density of electrolyte closer to that of water.

When this is fully realized it will immediately become apparent why precautions need to be taken during the winter to prevent the storage battery from becoming frozen.

Below is a table showing the various states of discharge and the temperatures at which the electrolyte will freeze.

Specific Gravity	Point of Charge	Freezing Point
1.280	100%	98 below zero
1.260	75%	60 below zero
1.225	50%	38 below zero
1.160	25%	zero
1.150	0%	13 above zero

When the battery freezes it is completely ruined and cannot be repaired, therefore special attention should be paid to the battery during the winter, whenever it has fallen to a condition of 1.225 or half charged, as any sudden snap of severe frost may result in the ruination of your battery almost before you are aware of the change.

In keeping a check on the discharged condition of your battery during the winter, it is important to bear in mind just how all operating conditions are changed during the cold weather, for example—

Engine works stiff.
Carburetion is slow.
Takes more current to start.
Days are shorter.
Lights required oftener.

Each of the above conditions result in greater amount of current being drawn from your storage battery.

The roads are generally more slippery in the winter, therefore you drive more slowly, consequently you do not put back the same amount of current as in the summer, therefore careful check must be made on the condition of charge in the battery.

Winter Storage

If it is not intended to use the battery during the winter it should be placed in winter storage.

There are two methods of winter storage.

(a) Wet storage.
(b) Dry storage.

Wet storage merely consists in keeping the battery in a cool dry place, keeping it clean, topped up with distilled water, and giving it a charge until the electrolyte "boils" once each month.

Dry storage consists of first fully charging the batery until it "boils." Adjust the specific gravity until it is equal in each of the cells. Then empty out the electrolyte, open up the cells and submerge the positive elements in a tank of cold distilled water, and the negatives in another tank of distilled water. Leave them in their respective tanks for several hours, until they can be exposed to the air without getting hot and smoking. Then store in a cool dry place.

The separators and the electrolyte must be thrown away, and fresh separators and electrolyte must be substituted when re-assembled in the spring.

The great advantage in dry storage over wet storage is due to the fact that all the elements in the battery are rendered inert. All chemical action is arrested during the whole period of dry storage, whereas during the whole period of wet storage chemical action is continuous. Therefore should this period extend over a period of say 5 months, the wet storage would have taken 5 months wear out of the battery, whilst the dry storage would have added 5 months to the life of your battery.

From a careful perusal of these brief articles on the storage battery, the author is hopeful that this important adjunct to the various scientific appliances which now enter so largely into our daily lives, will no longer remain that profound mystery, which has hitherto gained for the storage battery the alluring title of "The Black Box of Mystery."

MR. CARRUTHERS COMES BACK

Editor, Power House,

Sir:—Re Mr. Scott's "Dignified Protest" thanks for the caption, Mr. Editor, which goes a long way to show that you have no wish to see an East or West (in the question of a Dominion certificate), I beg to submit the following table in answer o his quesion "So why the dispartiy re the Ontario man?"

This is for the benefit of those engineers who, to use Mr. Scott's words "may attach some weight" to my letter in the July 20th issue on the Dominion certificate. Your notes re this same letter, Mr. Editor. merit some correction, but do not think it would do any good to forward you the proof, and am satisfied to leave the comparison of the table with intelligent engineers.

Cert. Alberta
3rd.—12 months firing.
2nd.—Above time, plus 24 months engineer 75 h.p. plant.
1st.—Above time, plus 12 months engineer 300 h.p. plant.

Cert. Ontario
3rd.—9 months firing.
2nd.—Above time, plus 12 months in charge of boilers.
1st.—Above time. No more steam service required.

The above table shows the steam serv-

(Continued on page 38)

Practical Method of Testing Centrifugal Pumps

Individual Tests Given to Each Unit—Proved Efficiency When Placed in Service—Interesting Method of Mounting Motor—Speeds Recorded on Vibration Tachometer.

DEFINITE characteristics of centrifugal pumps cannot be as accurately calculated in advance, as those of reciprocating pumps of various designs, and for that reason manufacturers usually prefer to test the former types before placing them in service. The reputation of the pump is thus guarded and at the same time statements, and guarantees as to performance, can be intelligently and confidently made.

Messrs. Darling Bros. of Montreal, manufacture a wide range of sizes of centrifugal pumps. Every pump is subjected to an individual test. To standardize results, and to make tests thoroughly and economically, a very interesting apparatus has been developed. Most of the impellers are bronze castings and practically all the pump casings are cast in iron.

It is not practical to machine some of the surfaces exposed to the liquids to be pumped, and in spite of the fact that the greatest care is taken in preparing the cores and setting them in the mold, small variations are found. This is only natural as molding can not be done to within a few thousandths of an inch. These variations are only infinitesimal but are reflected in the fact that capacities of the pumps vary slightly. For that reason this firm decided to test every centrifugal pump they built, and to do so in a very thorough manner under varying conditions. This would enable them to state with confidence just what every unit would do when placed in service.

Testing Appliance

The present apparatus was not designed, but rather developed from a basic idea. Improvements have been made from time to time, and now the apparatus is very complete. It is the intention of the firm to design a very complete apparatus from the data obtained in developing the original unit, which we are about to describe. The base consists of the bed of lathe. On one end of the base, or frame, is mounted a d.c. Allis-Chalmers-Bullock electric motor, which is used to drive the pumps to be tested. As the current supplied the factory is a.c. it was necessary to procure a source of supply of direct current. Nearby is located a belt driven d.c. Canadian General Electric generator of 6 k.w. capacity. The field rheostat of the generator, as well as motor rheostat, are located on the frame of the testing apparatus carrying out the idea of centralized control. At one end of the apparatus a switch board is located. This board carries the starter of the motor, an ammeter and a voltmeter.

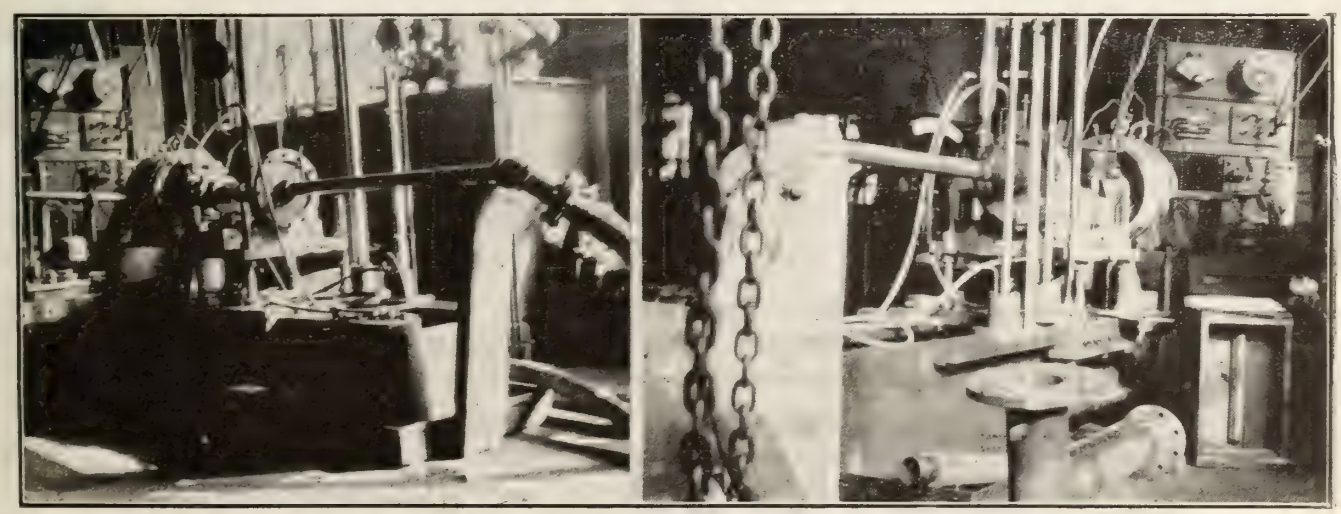
Unique Motor Mounting

The motor is mounted on the testing frame in a unique manner. It is held suspended at a fixed height in two bearing standards. The motor frame is free to rotate (on ball bearings,) about the centre line of the armature shaft. The armature is free to rotate with its shaft, independently of the motor frame, as in ordinary installations. The feet of the motor frame are in mid-air some eight or ten inches above the ways of the testing apparatus. A piece of 1 1-2 inch pipe is threaded into the side of the motor frame so that when the feet of the motor frame are in the horizontal plane, the pipe extends horizontally, at right angles to the centre line of the armature shaft, and with the axes of both pipe and shaft in the same horizontal plane. This arm is made to press on the platform of a very sensitive Toledo scales of the dial indicating type and originally designed for shell work. A special dial has been placed in the scales, reading pounds and tenths of a pound. An ingenious arrangement has been provided to take up the effect of any angularity of the arm. This is shown in Fig. 1. It might be mentioned that the effective length of the arm, measuring from the centre line of the shaft, is 31.416 inches, or ten times pi., which greatly facilitates calculations. The armature current is brought from the generator to two binding posts on the stationary standards which support the motor. The current is carried over to the frame of the motor, and thence to the brushes and field coils, (the motor being shunt wound,) by means of two conductors of brass wire cloth, which are very flexible and offer but infinitesimal resistance to the mechanical turning of the motor frame, which turning effort, or torque, is thus registered accurately on the scales.

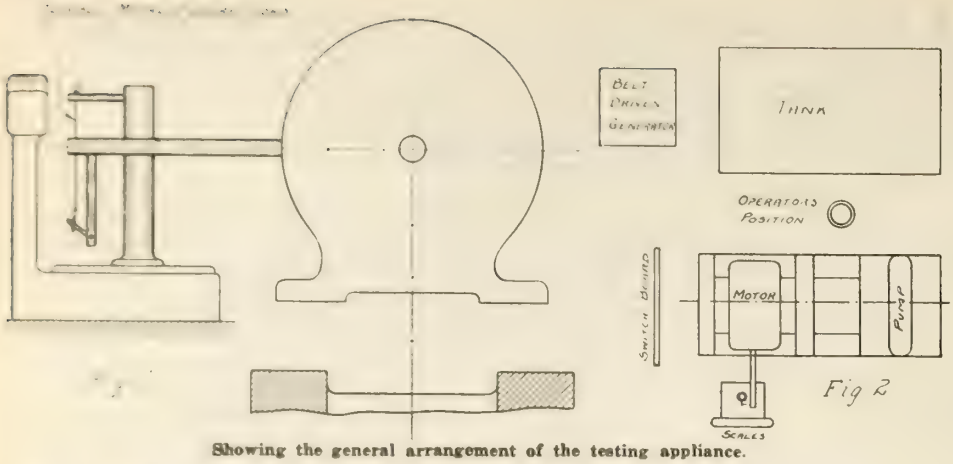
There are arrangements which provide for running the motor either way so that right and left hand pumps can be tested. Speeds up to two thousand r.p.m. are obtainable from the motor. The motor and pump speeds are recorded through the medium of a portable vibration tachometer.

Power Delivered

First impressions might suggest that the voltmeter and ammeter were used to determine the mechanical power delivered to the pump shaft. As electric motors operate at various efficiencies under varying load and speed conditions, this method would involve a new set of variables in the calculation and thus open up a new field for error. A characteristic curve of the motor would be necessary. To avoid these complications the ingenious and accurate dynamometer device is used to determine more directly the mechanical power delivered, without considering either mechanical or elec-



Two Views of Darling Bros.' Installation For Testing Centrifugal pumps.



Showing the general arrangement of the testing appliance.

trical efficiencies. The meters on the switch board are used largely to determine the loads on the motor and generator and thus guard against overloading. As before stated, the generator is a 6 k.v.a. machine, but when large pumps are being tested, a steam driven generator of larger capacity is used.

There is a flexible coupling on the motor shaft which is used to connect up to the shaft of the pump to be tested. The coupling also provides for the small amount of end play that it is desirable to have in the pump and in a motor of this type.

Locating the Pumps.

On the ways of the apparatus, toward the end remote from the motor, a sliding carriage is located. It presents a flat square surface and is gibbed to the ways. Provision for locking in any desired position is made. This longitudinal motion is used in locating the pump. Vertical adjustment is also provided. There are four threaded posts of generous cross section, located, one at each corner of the carriage. A platen is supported on these posts. Lock nuts above and below the platen permit of its adjustment to any desired vertical position. When a pump is being tested, the pump frame is bolted or clamped to the platen. The adjustments just described permit of the necessary movements required to line up the pump shaft with that of the motor.

Hydraulic System

The hydraulic arrangements are very complete. A 900 gallon steel tank supplies the water. It is open to the atmosphere. The suction pipe leads from the bottom of the tank. A complete arrangement of valves permits suction lines of desirable size to be coupled up. A combination of pipe and hose is used in nearly all lines for convenience in coupling up. A small hose is led off from the suction line to a mercury manometer, which indicates the amount of vacuum.

The discharge line is led to a 4 in. pipe header located near the ceiling. From the discharge line also a small line is taken, which line is led to a mercury manometer, which is graduated to read directly in feet of head and pressures, up to 70 feet and 30 pounds, resures a specially graduated pressure gauge is connected to the line, there being a small "T" in the manometer line and valves which would permit the cutting out of the manometer.

From the header into which the discharge is led, there are three pipes leading vertically down to the tank. There are two 2-in. pipes and one 3-in. pipe, each provided with a Venturi tube. One 2-in. pipe has a 2-in. x 23/32 in. throat, the second 2-in. pipe has a 2-in. x 1-1/16 in throat, while the 3 in. pipe has a 3 in. x 1-3/4 in. throat. Each Venturi tube is connected with a third manometer. Three scales are provided. These scales are removable and to read the discharge from any of the tubes it is only necessary to place on the proper scale and to cut out the other tubes. This is easily done as valves are provided. The discharge can be made through any one of the three tubes, or any two, or all three can be used at once. To get the total discharge in the case where more than one tube is used it is necessary to read the discharge of each tube separately. The whole apparatus is so designed that an operator can remain at one point and control and gauge every part of the apparatus.

The device has been developed largely in the plant and at no small expense. The calculations are very simple and in most cases the data are read directly The only calculation is that of the power supplied. When this is figured, it is a comparatively easy matter to deduce all the data required. As variable velocities are possible, the action of pumps under a wide range of speeds can be obtained. Valves are placed in the lines so that the vacuum in the suction line can be varied, and also the discharge pressures by valves in the lines containing the Venturi tubes. Complete data of the performance of a pump can be obtained in a remarkably short space of time.

COILS FOR COLD BOX

(Continued from page 32)

culation of larger volumes of air than is necessary, thus throwing more work on the coils.

We have seen a cool room laid out in the manner described, except that in this case the chocolate was not carried through the room on a belt, but was laid out on tables. There were in addition a couple of men in the room from time to time, unloading fresh batches and removing the cooled chocolate. There is another advantage in having the coils on the roof, in that it leaves the floor of the room quite clear.

MR. CARRUTHERS COMES BACK

(Continued from page 36)

ice, in addition to shop time, required in the two provinces. The one year in charge of a 300 h.p. steam plant required by Alberta could not be secured by the local man unless he had a 2nd class cert., thus making his total steam service 4 years, compared to 1 year, 9 months in Ontario. Of course, this disparity "is only small talk," according to Mr. Scott and some others living in provinces where certificates are more or less easily obtained and will never be noticed when exchanged for a Dominion "Uniform" certificate. Mr. Scott's remarks re motor-driven air-compressors may apply in the east but not the west.

Yours truly,
J. A. Carruthers,
Master Mechanic.

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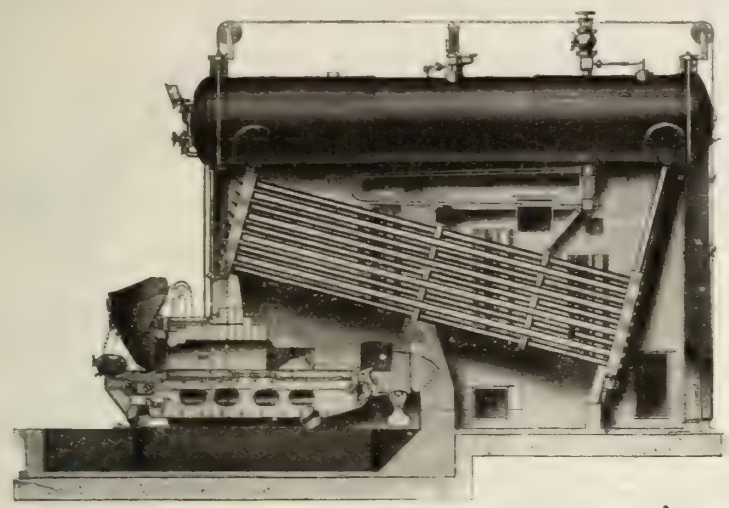
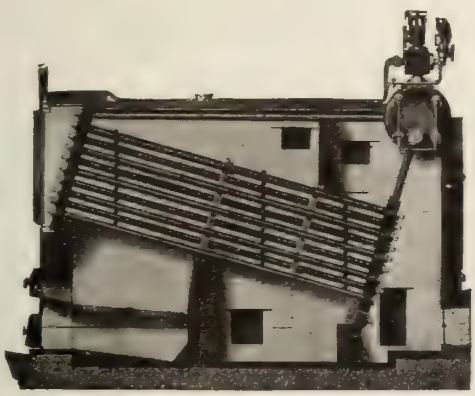
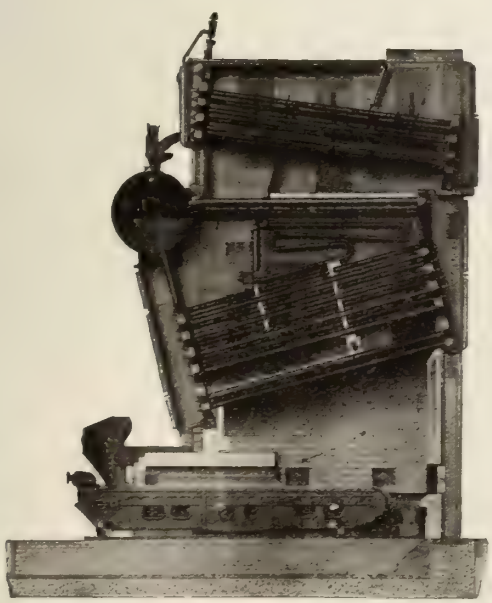


W. I. F. TYPE—With chain grate stoker and superheater suitable for most purposes on land.



CROSS-TYPE—A most desirable form of boiler where headroom is limited.



MARINE TYPE—(For land purposes). The marine-type boiler is equally adapted for installation on Land and is especially suitable for electric generating stations and other quick steaming plants. Where ground space is limited, and expensive, it offers particular advantages.

THERE IS A TYPE OF B. & W. BOILER

TO SUIT EVERY CONDITION ALL HAVING THE SAME PRINCIPLES OF CONSTRUCTION, VIZ:—

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Water divided into sections, no general explosion can occur.

Every section able to contract and expand without interfering with any other part of boiler.

Boiler as a unit can move without disturbing setting.

Positive circulation of the water keeps all parts at nearly uniform temperature.

Proper workmanship.

Materials which experience has shown to be the best for the particular purpose.

A great excess of strength over legitimate strain.

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W. R. Sexton Boiler Setting Co., Toronto

CORD CLOTHING
D. K. McLaren Limited, Montreal, Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd. Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Shell Bar Boico Supply Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal
Canadian Johns-Manville Co., Ltd., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. A., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Beveridge Supply Co. Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W.R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCullough Co., Galt.
Leonard & Sons, Ltd, E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd, Toronto.
Gelinas & Pennock, Reg'd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co. Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren Limited, Montreal, Que.

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N. Y.

CLEANERS, BOILER TUBE CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
R. C. Miler Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal
Godfrey Conveyor Co., 106-110 Richmond St. West Toronto.
MacGovern & Co., Inc., Montreal, Que
Northern Crane Works, Walkerville
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Prantford, Ont.

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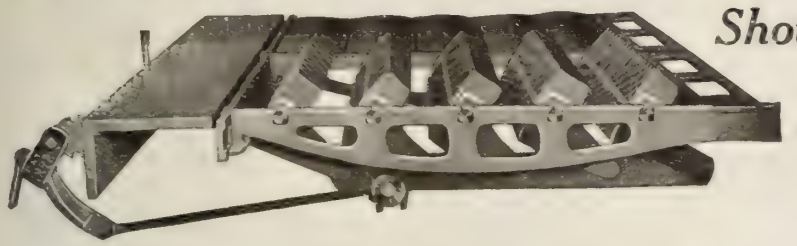

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New and Used—

Equipment that shows clearer than words the Petrie policy of quality, service and satisfaction.

Firebox Boilers
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FULL LENGTH Strokes At All Speeds

Although these pumps are double-acting, one of the usual two Ram Glands is dispensed with, reducing the vertical dimensions to practically those of vertical piston pumps. A brass sleeve protects the ram from all dust and ashes.
In cases where the work is variable

HEPBURN Patent Vertical RAM PUMPS

will run at a very slow, as well as at normal speeds with reliability and will maintain their full stroke under any circumstances.

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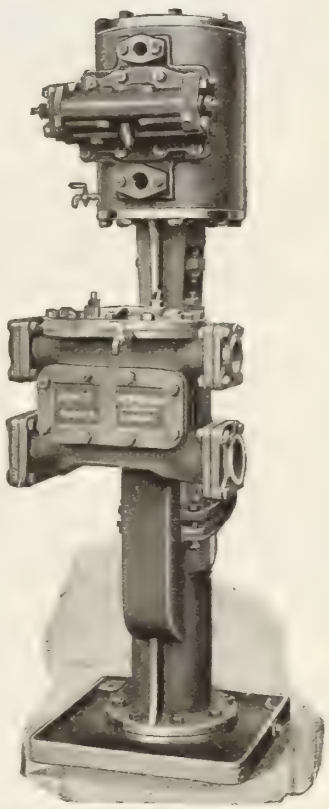

JOHN T. HEPBURN, LIMITED

Engineers and Iron Founders

18-60 VAN HORNE ST., TORONTO, CANADA

A Striking Message

A STRIKING message to manufacturers of power-house equipment is derived from a letter written by a "Power House" reader in reply to a request for a criticism of the paper and for suggestions as to how it could be improved. Here is the letter:

"I believe Power House compares favorably with other power-house journals in many respects. One department I would like to see at least three times its present size is the selling section. Many of the ads. are from all-American U.S. firms but there must be many others, some of them with Canadian branches and agencies, who do not carry an advertisement in Power House. **This is a mistake on their part,** but for all I know to the contrary it may be due to the lack of energy on the part of the Power House ad. manager in getting after them. **It is an absolute fact that the engineer is more than ever dependent upon his technical journals for information in connection with new ideas in power plant equipment. He does not depend upon the reading pages so much as on the ADVERTISEMENT PAGES."**

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Can. Mead-Morrison Co., Ltd., Montreal

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal

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Frick Co., Waynesboro, Franklin Co., Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal Que.

COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, CARBONIC ACID GAS
Arthur S. Leitch Co., Ltd., Toronto.
Laurie & Lamb Montreal.

CONDENSERS
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, ue.
The John H. McGowan & Co., Cincinnati, Ohio.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
Beveridge Supply Co., Montreal.

CONDUITS
Canadian Johns-Manville Co. Ltd., Toronto

CONDENSATION RECEIVER
The Mason Regulator & Eng., Co., Ltd., Montreal.

CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.

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Godfrey Conveyor Co., 106-110 Richmond St. West, Toronto.
Godfrey Conveyor Co., Elkhart, Ind.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insultaion Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS, REVOLUTION, FOR ENGINES AND PUMPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass
Schaffer & Budenberg Mfg Co., Brooklyn, N. Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay Ont
Can. Fairbanks-Morse Co. Ltd., Montreal

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont
Northern Crane Works, Walkerville, Ont
Smart-Turner Mach., Co. Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto
Northern Crane Works, Walkerville, Ont

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto.
Northern Crane Works Walkerville

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Babcock Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaffer & Budenburg Mfg. Co., Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP- FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg., Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal
B. F. Sturtevant Co., Boston, Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
MacKinnon Steel Co., Ltd., Sherbroke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co., of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg., Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Prantford.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F. Toronto, Can.

EXHAUST HEADS
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N.Y.

EYE BOLTS

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F. Toronto, Can.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Laurie & Lamb, Montreal.

FILTERS
Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Graver Corp., East Chicago, Ind.
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal .
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE STEAM
Dart Union Co., Ltd., Toronto, Ont.

FITTINGS, AIR, AUTOMOBILE, GAS, HYRDAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane Limited, Montreal.

FITTINGS, CAST IRON
Crane Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto. Ont.

FLOOR AND CEILING PLATES
Crane's Limited Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
Canadian Johns-Manville Co. Ltd., Toronto

FLOW METERS (AIR, GAS, STEAM, WATER)
Bailey Meter Co., Limited, Montreal.
Bailey Meter Co.
Dominion Flow Meter Co., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Metaer Co., Toronto.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, iMch.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Canadian Johns-Manville Co. Ltd., Toronto
Johns-Pratt Co., The, Hartford, Conn.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HAND-HOLE
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Peldam Asbestos (Canada) Co., Toronto.
Canadian JohnsMansville Co. Ltd., Toronto
Can. Steam Boiler Equip. Co., Toronto
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa
Garlock Packing Co., Hamilton. Ont.

GASKETS, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, LEAD, COPPER AND LEATHER
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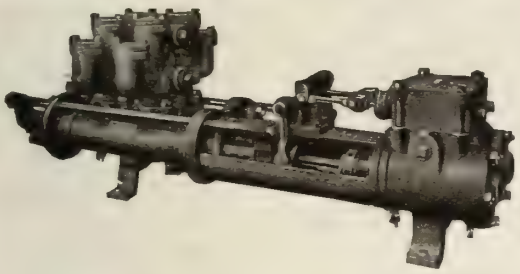

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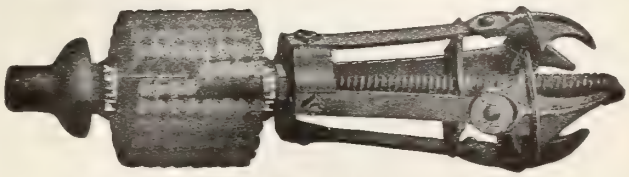

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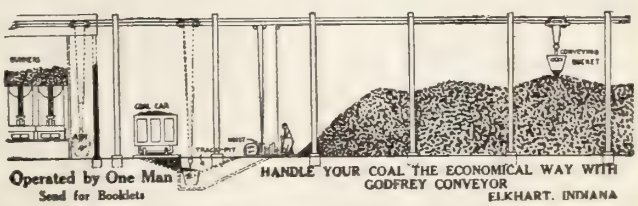

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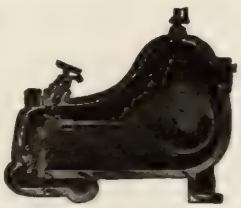

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WATER

PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

5 Retort RILEY STOKERS installed under 487 H. P., G. & McC. boilers.
Smith, Hinchman & Grylls, Consulting Engineers, Detroit.

More Steam at Lower Operating Cost

THE PROBLEM.

At the plant of Hiram Walker & Sons, Ltd., Walkerville, Ontario, more steam was required. Their boiler room contained 10—125 H.P. boilers. These boilers were economically fired but the plant layout in general was inefficient.

THE SOLUTION.

They replaced these *10* boilers with *3* of 487 H. P., fired by Riley Stokers which now gives them ample steam capacity. Although the normal boiler H. P. is increased but little the *actual* capacity is about three times greater because the Riley Stokers will operate the boilers up to 250% of rating or more. *When the above picture was taken two of the boilers were making 200% of rating.*

THE RESULT.

Greatly increased capacity with a *reduction in operating expenses.* The improved power plant layout with automatic coal and ash handling equipment and Riley stokered boilers has made possible a reduction in labor from 8 men to 2 men per shift. This saving in labor alone amounts to nearly $100 per day.

Find out what the Riley can do for you.

Send for Catalog H-9

THE UNDER-FEED STOKER CO. of CANADA LTD.

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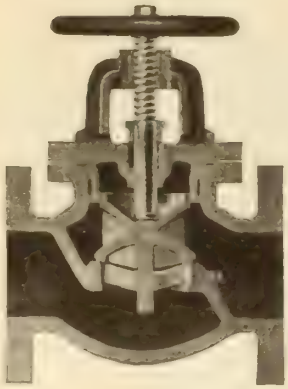
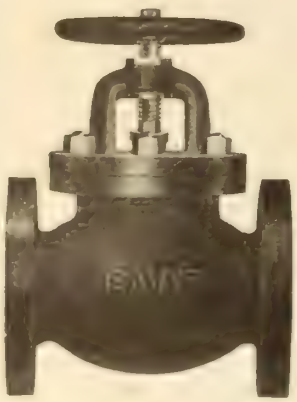
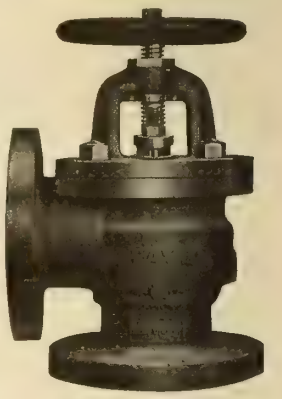




"Beaver" Non-Return Stop and Equalizing Valves

are the engineers' choice due to their records for trouble-free performance.

This performance is obtained by simplicity and proper construction.



In the Beaver Non-Return Stop and Equalizing valve the moving parts are cast and machined in one piece, being absolutely true to begin with and having no screwed connections to work loose and cause the valve to stick, due to the parts getting out of adjustment. The bronze dash pot is hung from the top, giving freedom of expansion.

The yoke makes a metal-to-metal joint with the body, no gasket being used.

An important feature in the design of valve is the areas through the body and seat and in this particular liberal allowance has been made in the construction of "Beaver" Valves. At no point are they cramped, nor will they obstruct the free flow of steam or water, the areas being in excess of the nominal diameters of the connecting pipes, yet the valves occupy a minimum of space.

The stuffing box gland being made of bronze offers a non-corrosive surface for the stem and also prevents the gland breaking when the stuffing box is being packed.

"Beaver" valves are designed for a working steam pressure of 250 lbs. per square inch and are subjected to a hydraulic test of 500 lbs. per square inch before leaving our factory.

All of the wearing parts can be renewed, should they become worn or broken.

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Co. Limited

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A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL, WINNIPEG, VANCOUVER — LONDON, ENG.: 88 Fleet Street, E.C. — NEW YORK, BOSTON, CHICAGO

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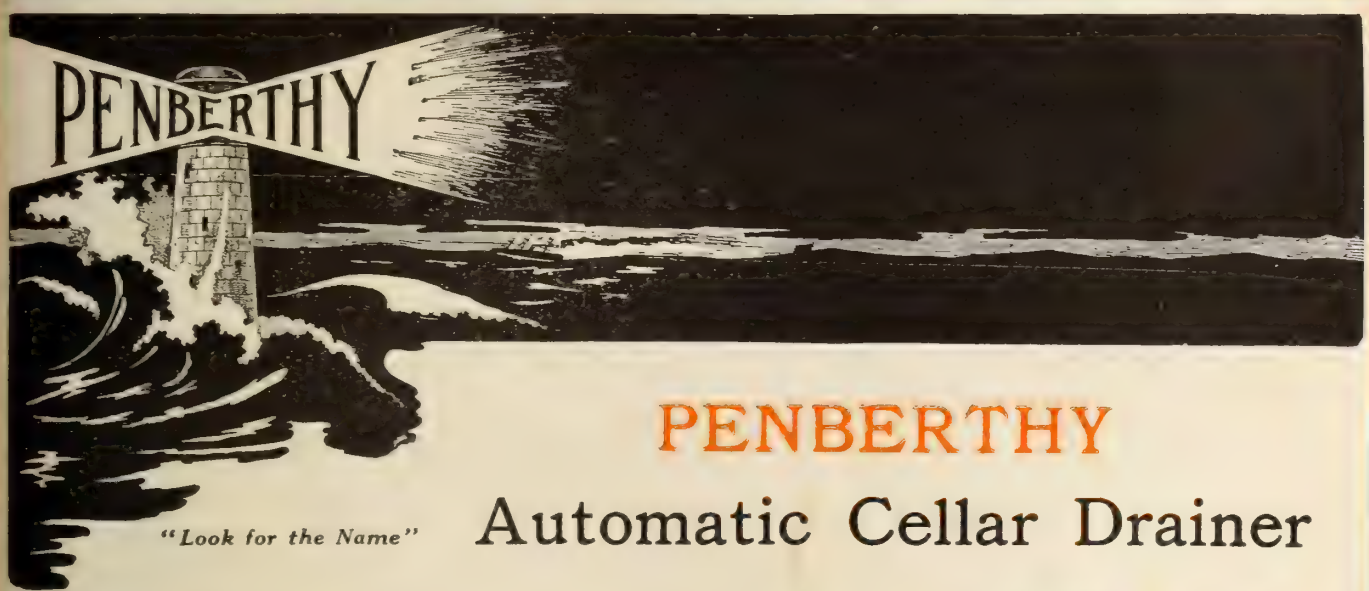

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Automatic Cellar Drainer

THE PENBERTHY Automatic Cellar Drainer is a Penberthy water pressure ejector of high capacity, automatically operated by a float-controlled, quick-opening-and-closing valve C. This valve is never partially opened—it cannot leak. The float arms are slotted at A, which prevents the ejector from operating until the water has raised the float up to the highest point. This allows the machine to work for longer periods and not so often, thus preventing considerable wear and the leakage and dribbling of water, so common in the majority of drainers.

For the purpose of compactness the float is flat on the top and is built around suction pipe B, ensuring perfect rigidity. All working parts, except the strainer and float, are above water. The special strainer H is so constructed that the water is drawn in at the sides so that sediment is undisturbed by suction. A foot valve inside the strainer instantly closes when the drainer ceases to operate, holding the pipes ready primed for the next filling of the sump.

Send for Catalogue on: Cellar Drainers, Injectors, Ejectors, Lubricators, Valves, Grease Cups, Oil Cups, Gage Cocks, Water Gages, Air Cocks, Whistles, etc.

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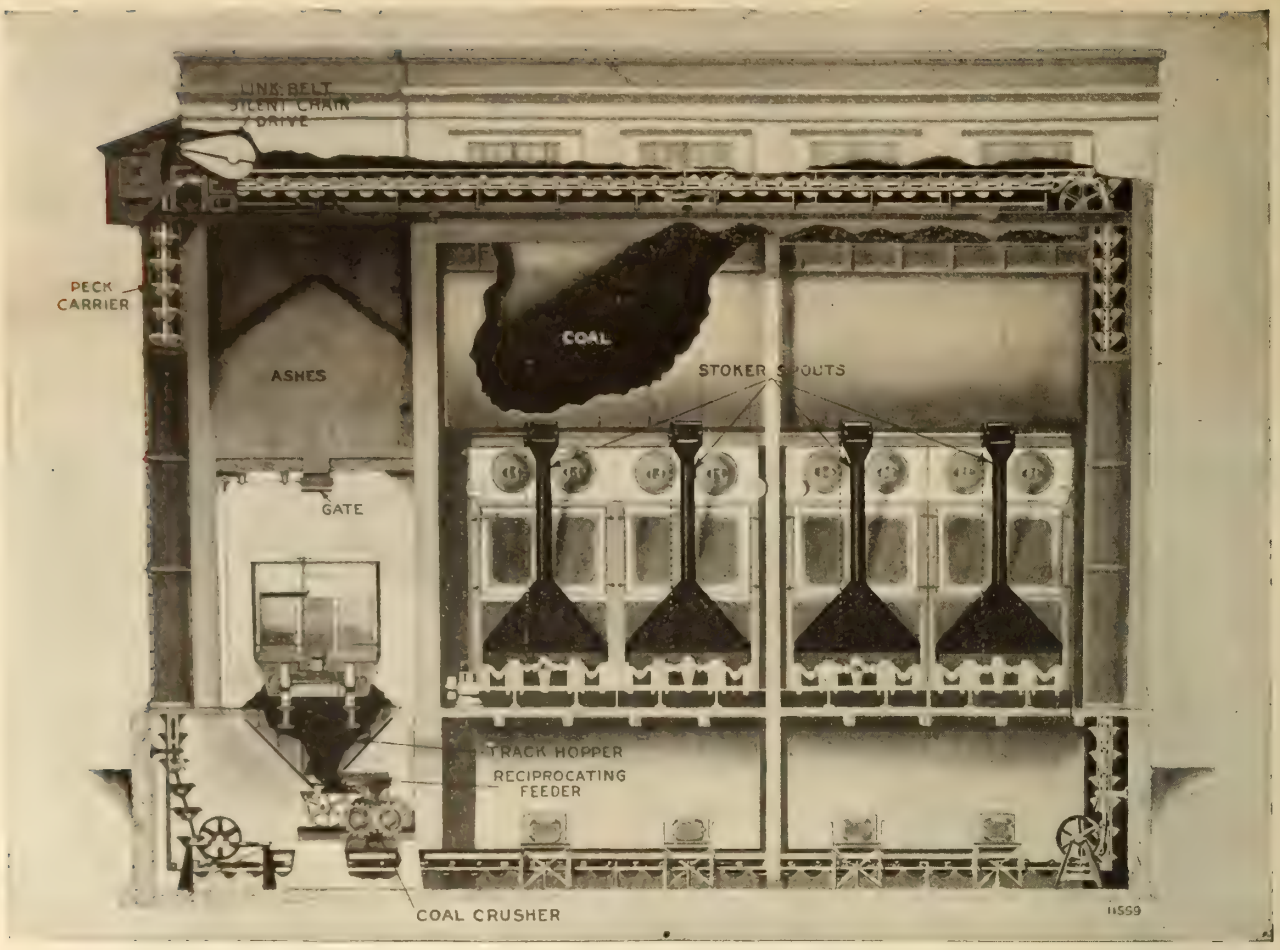

A Typical Boiler Room Equipped With the Peck Carrier for Handling Coal and Ashes

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DO you know that there is one efficient, sturdy and dependable machine which solves the entire problem of handling coal and ashes in boiler houses? It has been adopted as standard in hundreds of plants throughout the country.

This illustration shows how it is done with the Peck Carrier.

Is not so important a subject worth study by everyone who handles coal and ashes?

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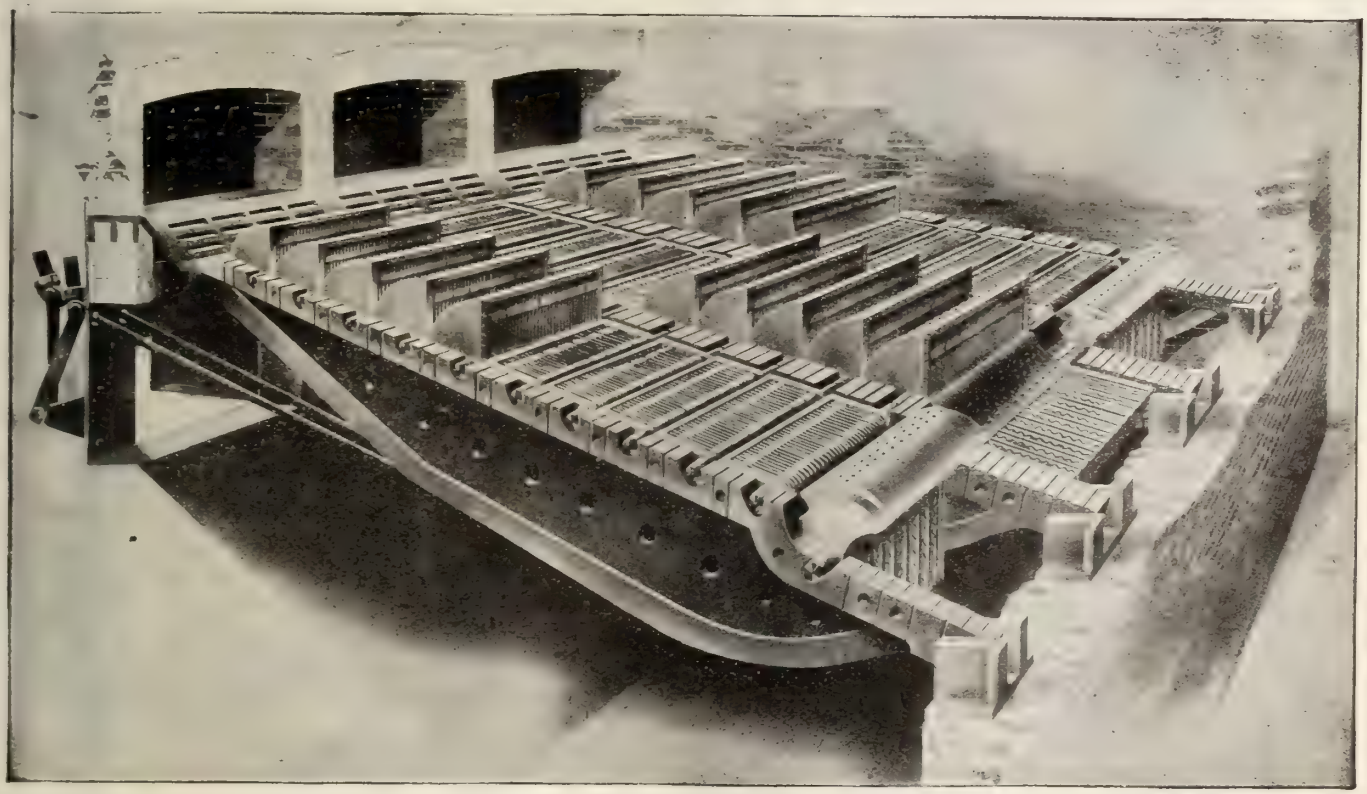

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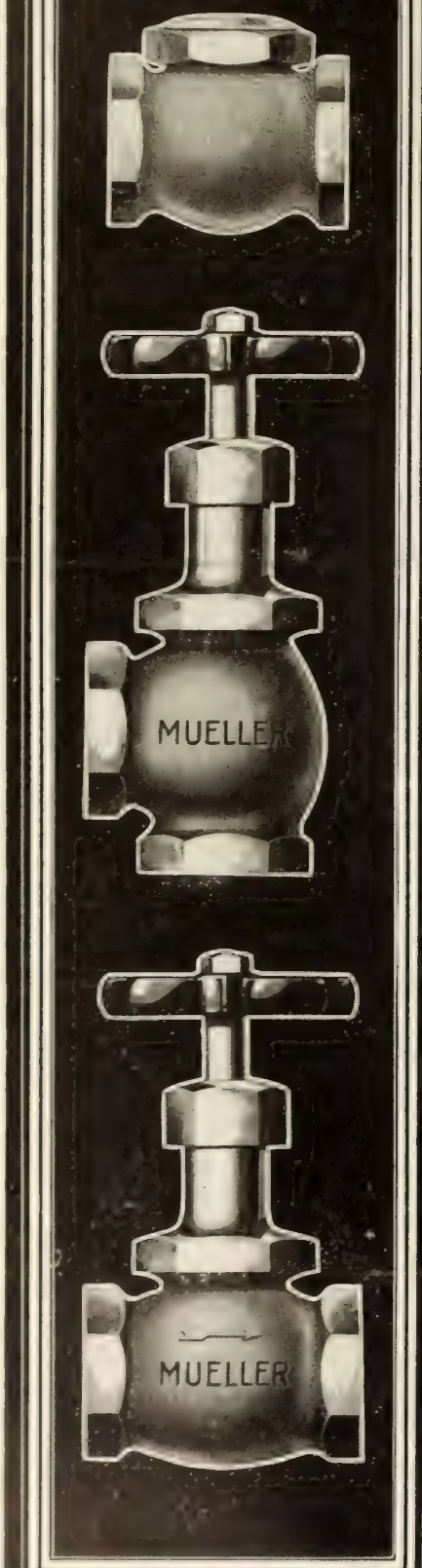

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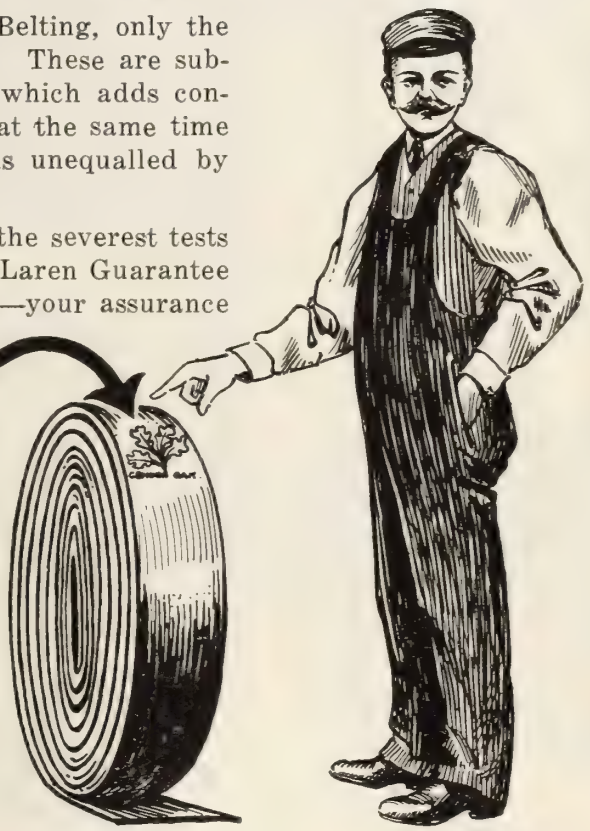

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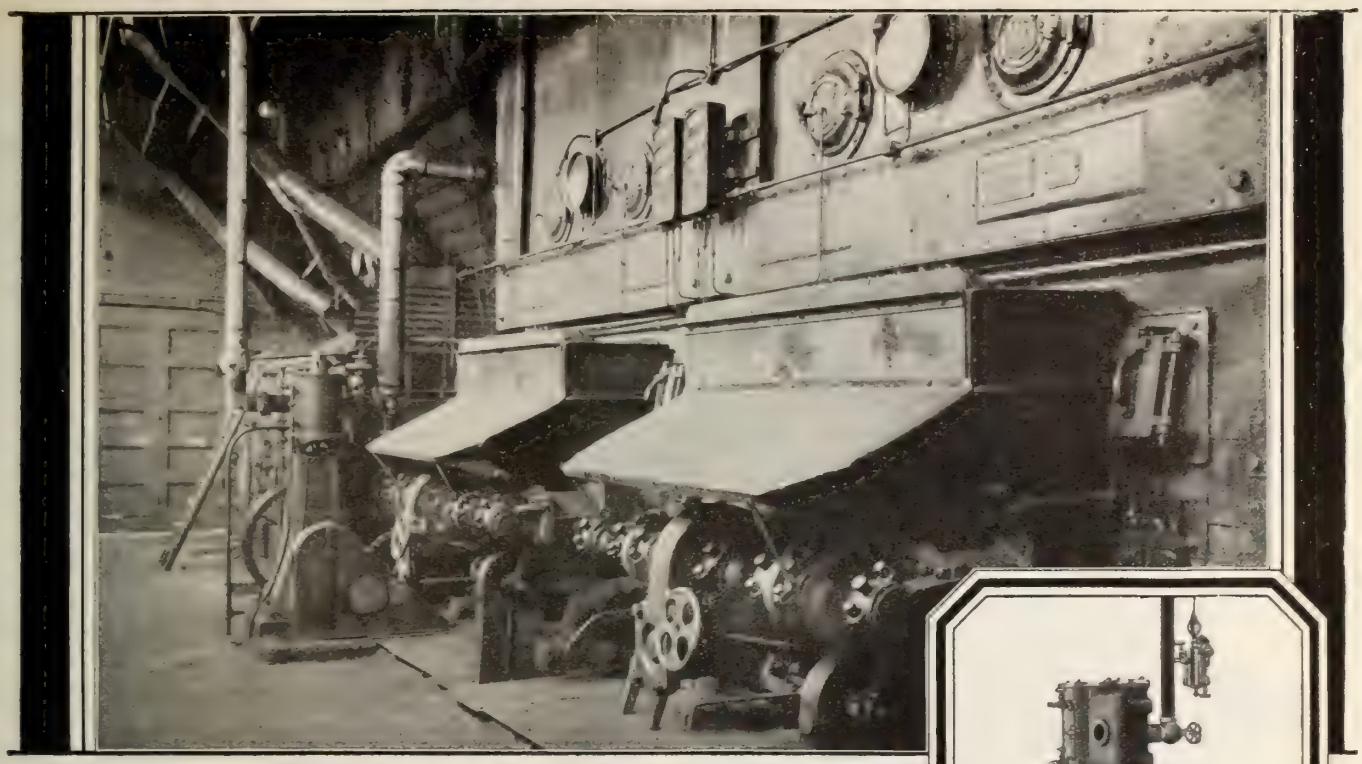

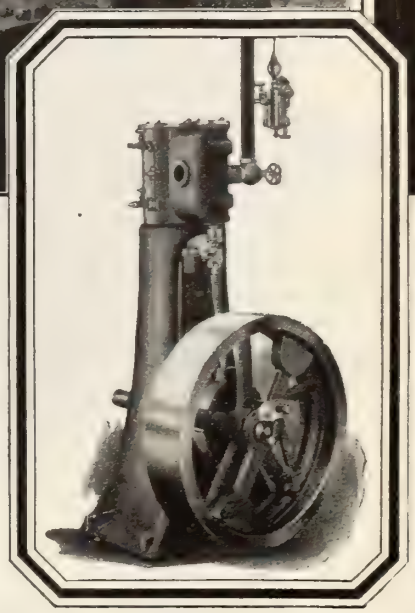

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In a certain power plant there is a CSC Vertical Self-Oiling Engine that is operating 24 hours daily—giving dependable, economical performance—assuring continuous service without delays.

This engine received the commendation of the superintendent, the engineer, the plant manager—all except the night-watchman. He complained that the engine ran too quietly—that he was required to make too many trips to the engine room only to find that the CSC Engine was operating faithfully.

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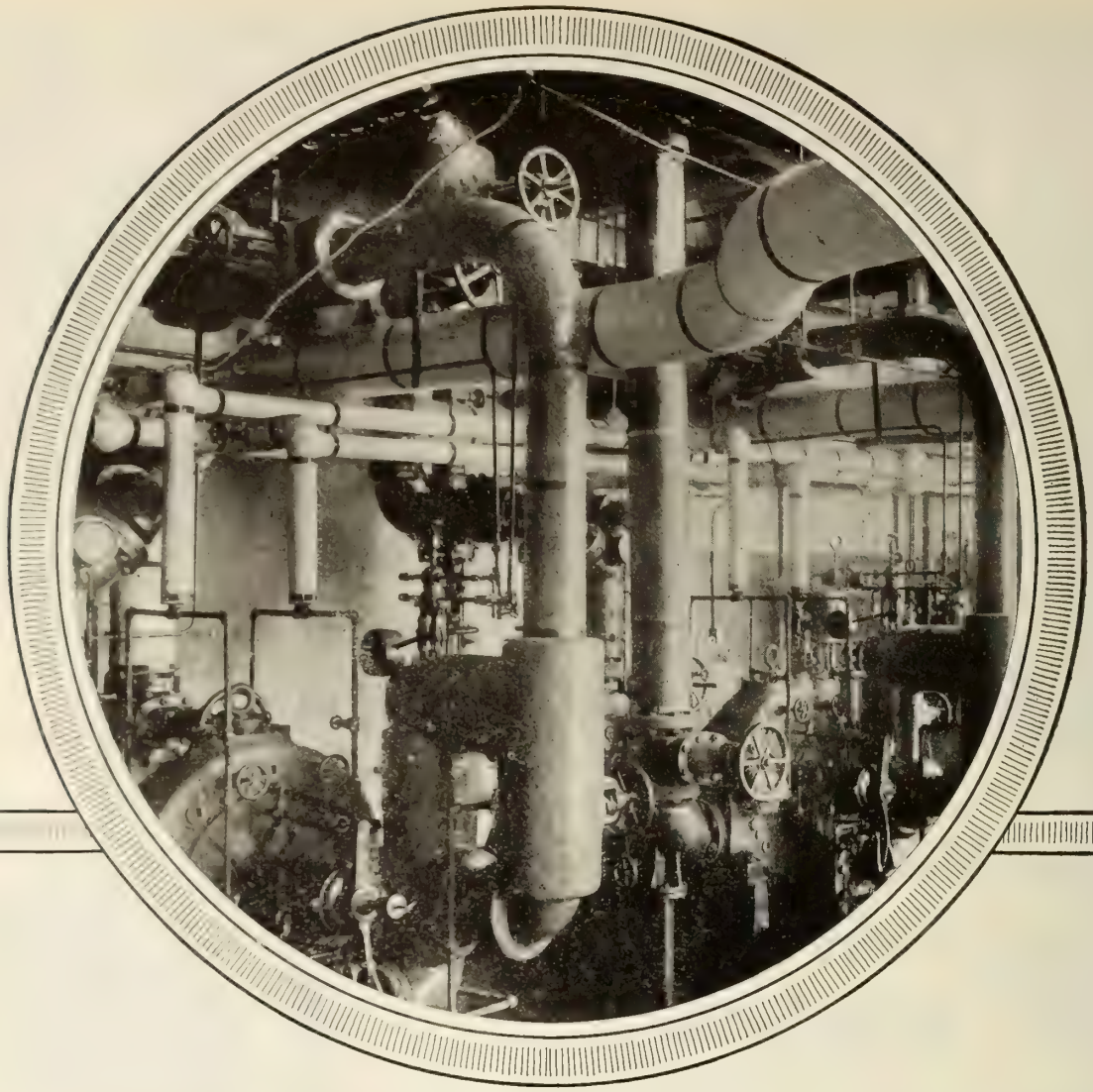

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They'll Stand Rough Usage and Careless Handling

SELCLO GLOBE VALVES

Selclo Globe Valves are made to stand the strain of extra severe service.

On steam, water or special service lines where valves are repeatedly opened and closed Selclo Valves give long and trouble-free service.

Selclo Globe Valves are especially suited to factory, shop and railroad roundhouse work where the service is exceptionally severe and where very often inexperienced people have occasion to operate them.

The Selclo Globe Valve is particularly recommended for use on vertical steam lines where condensation accumulates, as pressure being above the disc assures the valve being tight at all times.

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The popularity of Detroit V-Type Stokers in the public schools bears witness to their value from an investment standpoint, for all natural draft furnaces —whether under fire tube or water tube boilers.

Detroit V-Type Stokers are money-makers in schools, public buildings, industrial plants—and wherever used. With them: (a) average overall efficiencies of 70-75 per cent may be maintained, (b) operator can fill coal hoppers and then attend to other duties, (c) cheaper grades of fuel can be burned than with hand firing.

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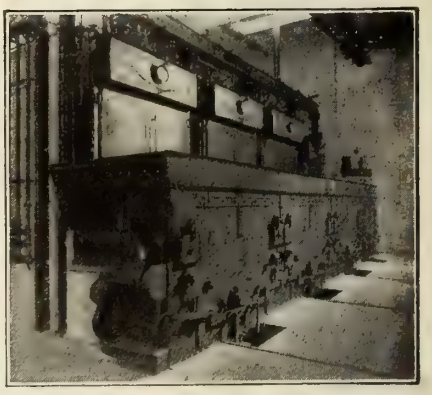
On every score your boilers should be equipped with Detroit Stokers. Remember, there is a type for every purpose—V-Type Overfeed for natural draft—Single Retort Underfeed for forced draft with boilers developing up to 300-400 H. P.—Multiple Retort Underfeed for large boilers.



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DETROIT UNDERFEED STOKERS

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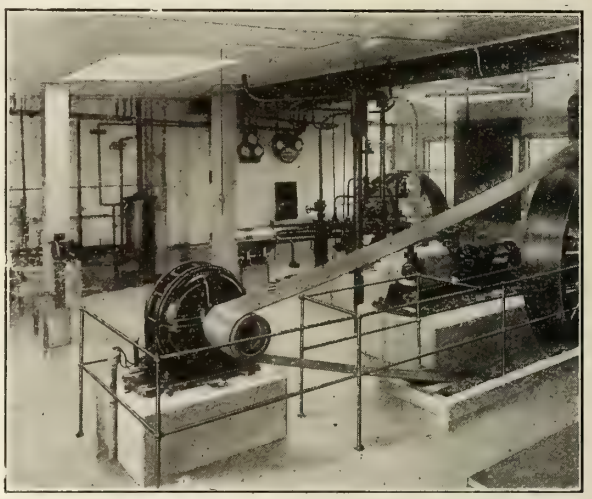

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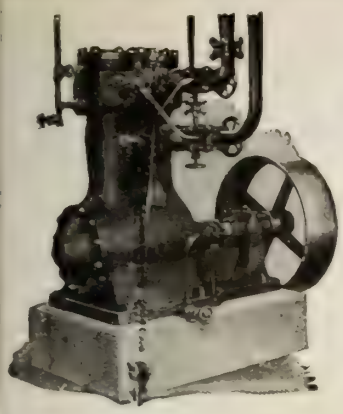

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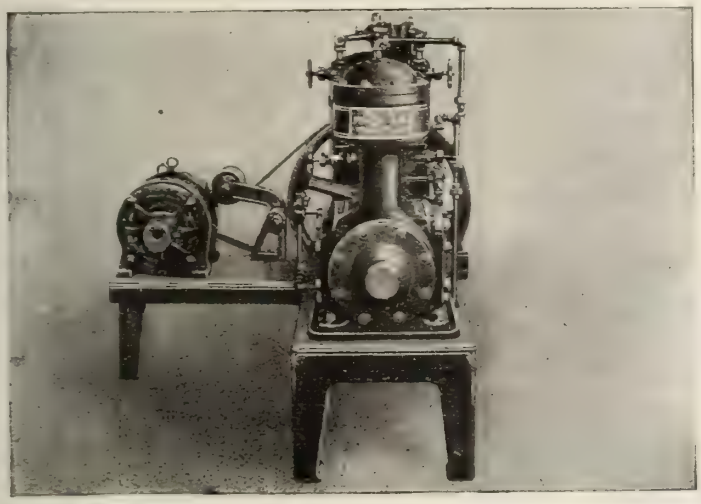

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The machine is manufactured in one ton and two ton sizes. It is a complete self contained unit, including compressor, condenser, separator, receiver and connections mounted on one solid portable iron base as shown. It is completely assembled in one crate with motor and motor base in separate box, and can be taken through a 26-inch door without uncrating.
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Machine is completely protected with safety devices. Either part automatic or full automatic control is supplied as desired. It is unusually quiet in operation and can be placed in any desirable location.

Ask our nearest distributor for further details and prices.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

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BRANCHES IN ALL PRINCIPAL CITIES

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Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

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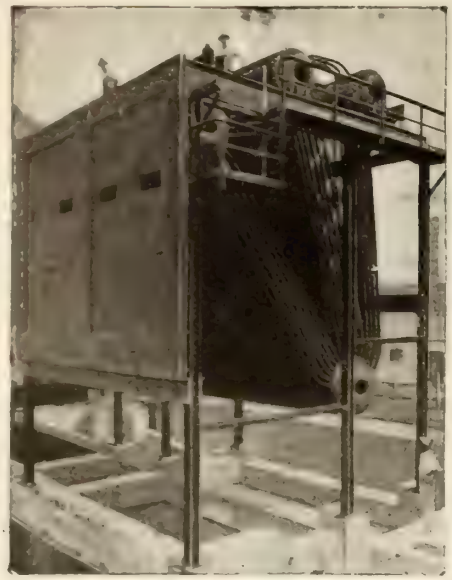

Connelly Water Tube Boilers

are of the 4-drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

All parts easily accessible for cleaning, both internally and externally. Can be built in units from 200 H.P. up to 4,000 H.P. and 300 lbs. pressure. Over 150,000 H.P. in successful operation.

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TRADE MARK

"PALMETTO"

REG. U.S. PAT. OFFICE

as it has on most other packings, especially those that have rubber in them.

"Palmetto" contains no rubber, or any other substance that is affected by age or climate.

No matter how long "Palmetto" remains in stock it is always the same quality as when manufactured.

For Long Service "PALMETTO" has no equal under STEAM (especially high pressure superheat) and COMPRESSED AIR.

Wherever the service is difficult there "Palmetto" is sure to give satisfaction

If you want to know how much longer "Palmetto" will last than the packing you are now using, ask us to send you a working sample to test—no charge.

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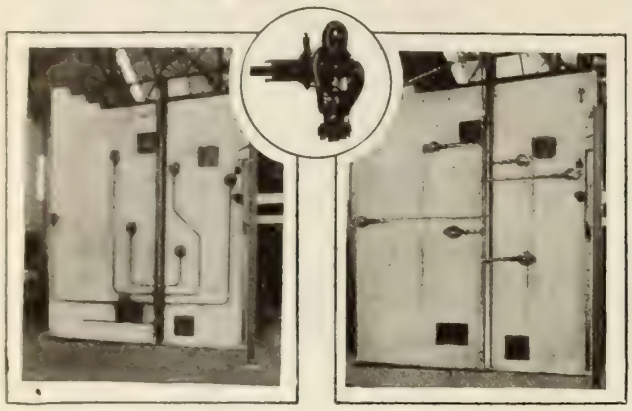
CANADIAN AGENTS:
The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.

Diamond Valv-in-Head Soot Blowers Save Two-Thirds Material Required for Installation



With the independent valve soot blower system above there is required 66 feet of pipe for connections to individual units, and six 2 inch globe valves.

With the Diamond Valv-in-Head System above only 23 feet of pipe is required to connect the units with the main line. All individual control valves are eliminated.

With the Diamond Valv-in-Head soot blower system it is possible to save approximately two-thirds of the cost of material required for installation with the independent valve soot blower system. There is an actual saving in pipe of two-thirds, a considerable reduction in the number of fittings and the complete elimination of individual control valves.

On a typical 6 unit installation the bill of material for the independent valve system comes to $195.48, with prices as of October 1st, 1922. With the Valv-in-Head system the complete bill of material amounts to $64.28. The saving effected is $131.20. (Note: Comparison made between bronze body valves with nickel seats and discs for independent systems and Monel trimmed Valv-in-Head.)

This saving in material alone bridges a long part of the difference in cost between the Diamond Valv-in-Head and the independent valve soot blower. Other Diamond Valv-in-Head economies include: a saving of 50 to 60 per cent. in steam for operation; a saving of 50 per cent. in labor and a reduction in annual maintenance charges of 25 to 50 per cent. or more. Remember that Diamond blower elements used in the hot passes of water tube boilers are protected from oxidation at high temperatures by being CALORIZED.

Write for Bulletin 287.

DIAMOND SPECIALTY, LIMITED, WINDSOR, ONT.

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

KERR

Dependable Service

DESIGNED and constructed according to the most modern and approved practice, KERR Valves have earned a reputation for dependable service wherever they are installed.

Our forty years' experience, the exercise of the greatest care in design and manufacture, rigid tests before the goods are shipped, and a guarantee by a reliable firm—these are factors that, in many cases, have led to the adoption of KERR Valves as Standard Equipment.

MADE IN CANADA.

The Kerr Engine Co., Ltd.

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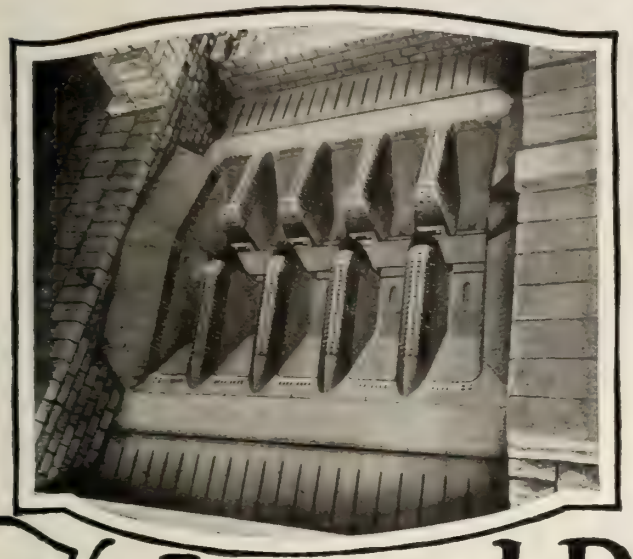


the greatest advance in stoker building

The Lateral Retort Stoker

TRADE MARK

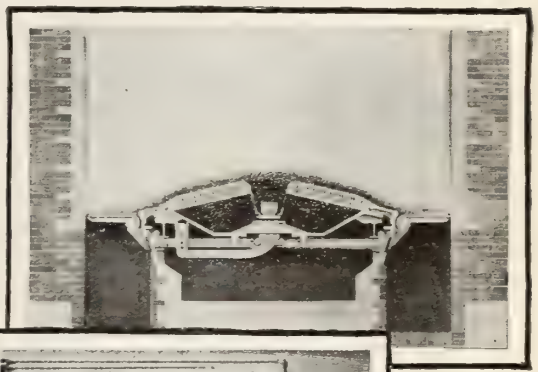
MULTIPLE retort efficiency with single retort simplicity —that is the gift of the Lateral Retort Stoker to the power plant world.

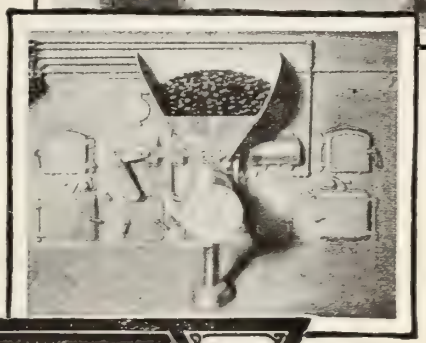
The view above shows how the multiple retort effect is obtained in an extraordinarily simple way. Coal is fed lengthwise into the main retort by the strokes of a steam operated ram. It is then distributed sidewise into the several lateral retorts. Only two steam cylinders and moving units are used, and the few moving parts are never subjected to the heat of the furnace—yet note how this firing method attains a degree of efficiency never before equalled in a stoker of equal simplicity.

The coal is under-fed throughout. Although a side dump is employed, the fuel is not over-fed on to side grate bars as in former side dump stokers. It is under-fed, not only to the main retort, but also to each lateral retort. The advantages of under-feed combustion are retained—distillation of volatiles is slow and thorough; coking is complete. This insures highest combustion efficiency, and the large reserve fuel capacity of the retorts insures heavy overload capacity and ability to handle sudden peak loads.

The coal feed to the main cylinder and to the lateral retorts is controlled separately, insuring an even fuel bed and increased flexibility.

By applying the multiple retort principle to a side dump stoker the necessity for excavation and basement ash pits is eliminated. This makes the installation cost extremely low. Also it makes the stoker adaptable to old boilers without making expensive changes. How extreme simplicity, made possible by this revolutionary basic principle, has produced a high duty multiple retort stoker that can be installed at a moderate cost is told in a new catalog. Write for it.





Under-Feed Stoker Co. of Canada Limited

146 King Street West, Toronto

Alta. and West Sask.: Mr. J. Twomey, Camrose, Alta.
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British Columbia.: E. A. Earle, Limited, Vancouver, B.C.;
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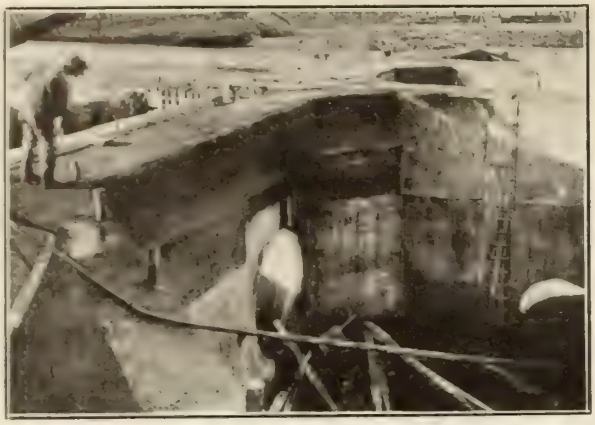
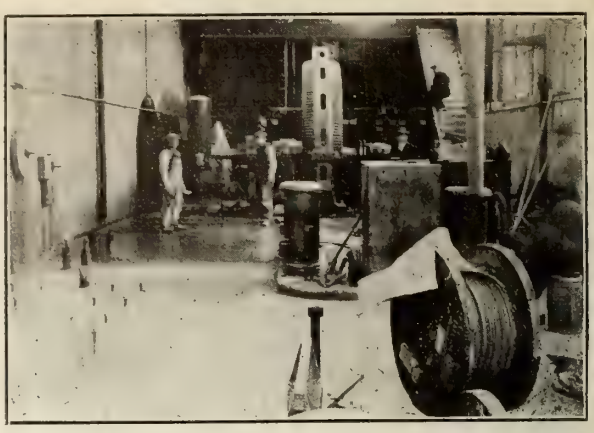
RILEY JONES

The UNDER-FEED STOKER COMPANY OF CANADA LTD.

MURPHY



Inside of Forebay—upstream face of Breast Wall—for 1600 h.p. unit.



Interior of Power House, showing Breast Wall.

The left wall of the Power House interior is the inside of the Breast Wall which shows in the illustration on the left.

The NASSAU POWER PLANT

of the

Canadian General Electric Company

At PETERBOROUGH, ONTARIO

This plant was constructed in connection with the reconstruction of the Nassau Dam by the Department of Railways and Canals. The first unit of the plant was put into operation in March, 1922.

The entire sub-structure of the Power House, including the forebay walls and draft tubes, is of concrete. It being essential that hydraulic losses should be reduced to a minimum, the draft tubes were finished with very smooth surfaces and well rounded corners.

The up-stream wall of the Power House is also the breast wall, and the interior of this wall is "bone dry," notwithstanding the pressure of the full head of 18 feet of water on the up-stream side. This result was obtained without the use of any water-proofing materials, which furnishes evidence of the value of concrete construction wherever a water-proof structure is required.

The Power House sub-structure was carried out in conjunction with the reconstruction of the Nassau Dam by the engineers of the Department of Railways and Canals, to the designs of Walter J. Francis and Company, the Consulting Engineers for the Canadian General Electric Company.

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FOR PERMANENCE

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On the way to the convention of State Navy Engineers last year, the subject of this advertisement was one of many subjects discussed. Read below whether we have proved an emphatic "Yes" to the question.

Can you run a plant on one sheet packing?

WHEN Johns-Manville in their packing standardization propaganda said, "One sheet packing for all conditions," many engineers told us it couldn't be done.

On the face of it, they seemed right. To expect any one material to pack against such widely different conditions as air, steam, water, oil and chemicals was beyond all experience.

But now the only doubters are those who haven't tried Johns-Manville Service Sheet.

In thousands of plants Service Sheet is the one packing used for every sheet requirement, including the most severe.

That fact can stand by itself. An hour's debate would not make it any truer or less true.

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To stock one packing instead of many is, obviously, an economy.

You reduce investment in packing.

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Some points of betterment

What is more, Service Sheet packs more satisfactorily than the materials it replaces. It is resilient—it will give to a temperature rise and come back without disturbing the joint. It is dense—and so a thinner sheet can be used, which means a stronger joint. It is durable—made of asbestos fibre and heat-resisting compounds, it withstands every wearing agent—and so obviates frequent replacements.

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Through—
Asbestos
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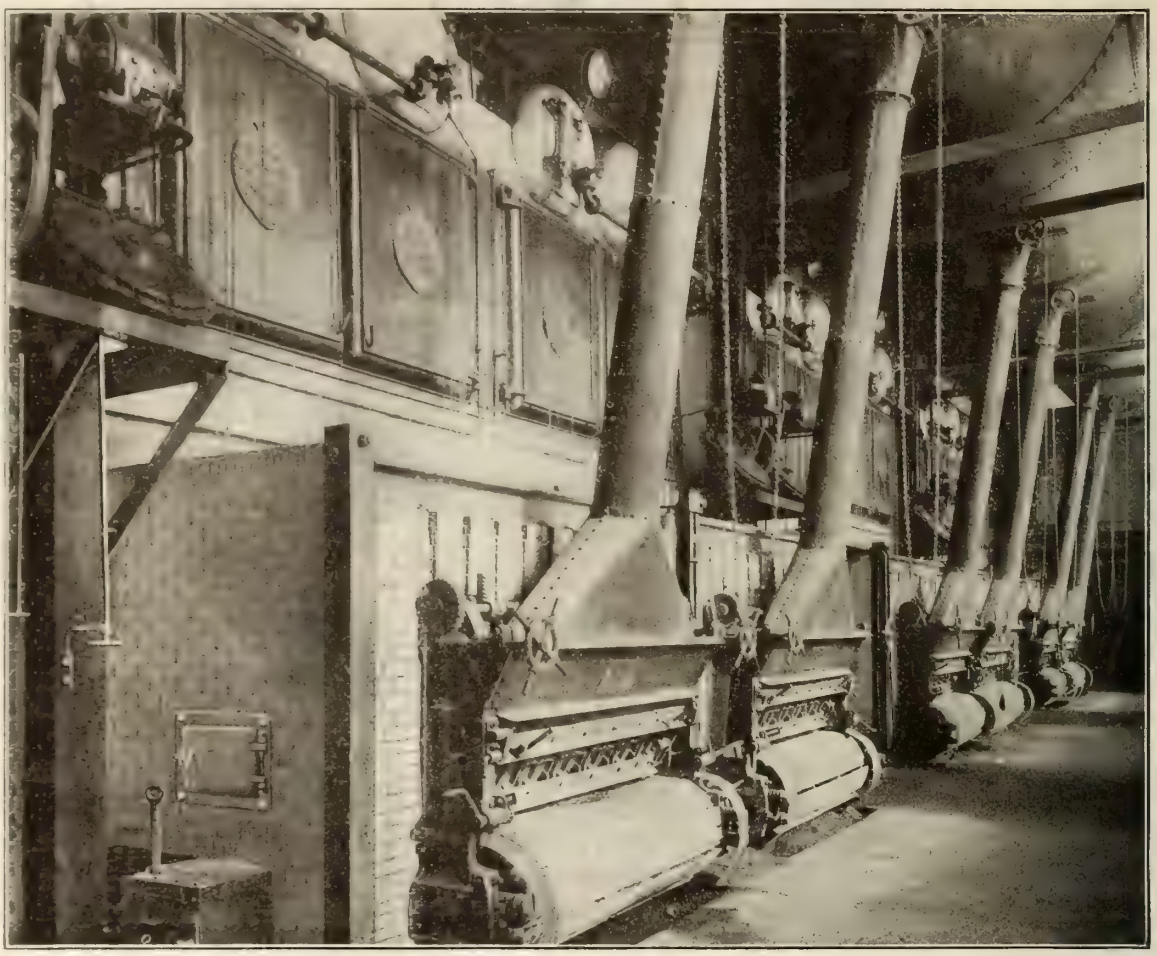
INSULATION *that keeps the heat where it belongs*
CEMENTS *that make boiler walls leak-proof*
ROOFINGS *that cut down fire risks*
PACKINGS *that save power waste*
LININGS *that make brakes safe*
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials



HIGH EFFICIENCY

From G. & McC. Co. Sectional Water-Tube

BOILERS

Large numbers of Canadian users have testified to the fact that they are providing highly satisfactory service in a wide variety of industries.

Ask for our new Catalogue and if you have Power Plant troubles of any kind, remember that our Engineering Dept. is at your service.

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POWER HOUSE

Members of the Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthl

Rolling Mill Engine of 25,000 Horse Power

Built on Marine Lines, for the Hardest Kind of Land Service— Working at Full Power it Reverses Four Times Per Minute— Three Cylinder, But Not Compound

IN THESE days of steam turbines of ever-increasing size and power a reciprocating engine of 25,000 h. p. is something of an achievement.

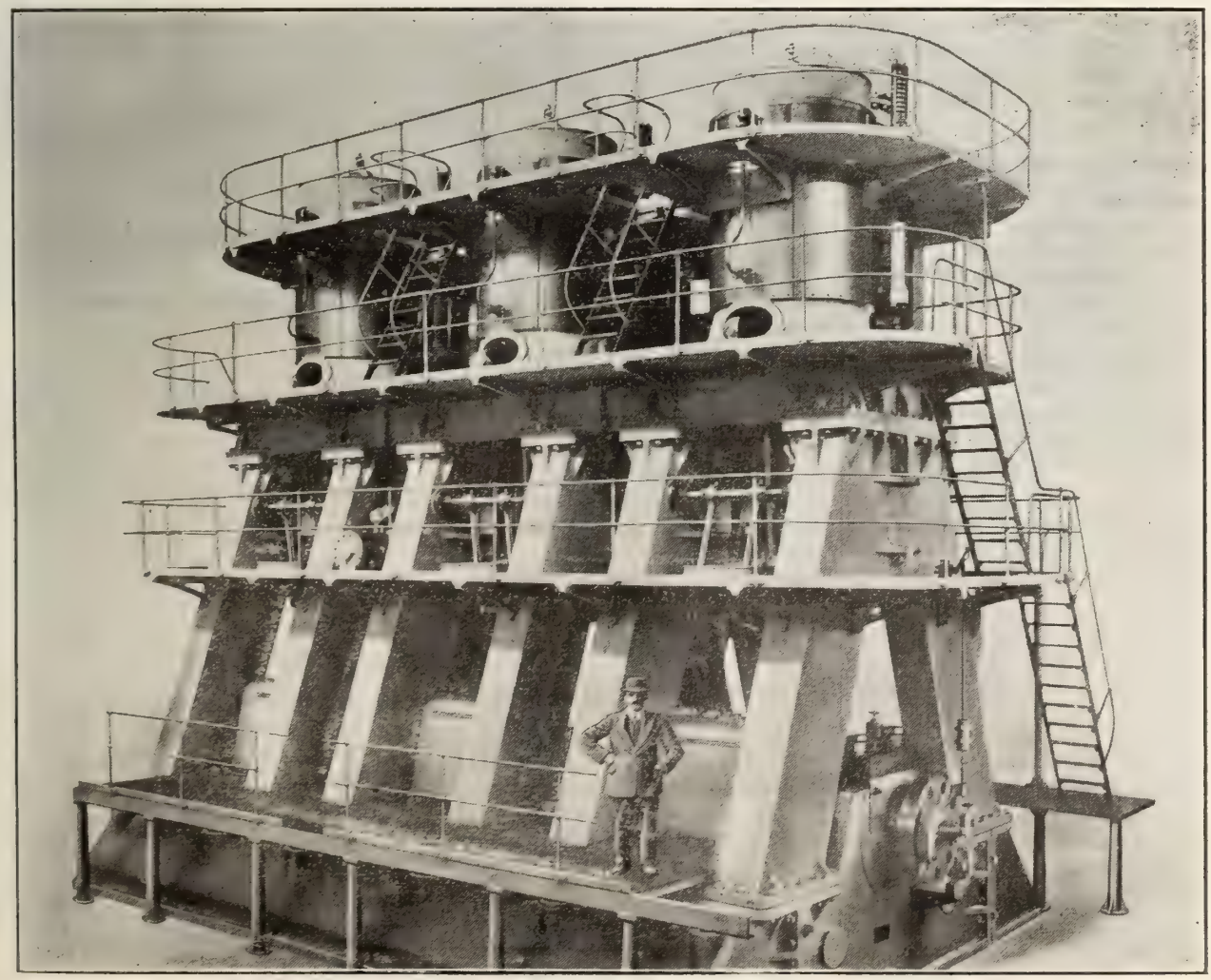
Such an engine was recently built for the Cargo Fleet Rolling Mills, which is one of the largest in England. It will be observed from the photos that it is built mainly on marine engine lines, so that it is not surprising to learn that it was built by a famous marine engine firm, Richardsons Westgarth of Middlesborough.

Not a Compound

There is no compounding in this engine, the three simple cylinders all taking steam at boiler pressure, 190 lbs., superheated 100 degrees.

The cylinders are 45ins. in dia. and have a stroke of 52ins.

This engine was built for speeding up the rolling of 24in. x 12in. steel joists, and other similar sections and it is required to reverse four times per



Front View of Engine.

minute, which is no mean performance in view of its size. The very heavy frame sections and the wide base were necessitated to give stability under this constant strain, the bed plate weighing some 105 tons and measuring 22 feet by 29 feet.

There are six main columns of the inverted Y type. These are made in two parts with a planed joint down the centre. In addition to the usual bolts the joints are specially strengthened by hoops cast on to bosses inside the joint.

The bearings shown on the column carry the main reversing shaft.

Valve Gear

The valve chambers are separate castings bolted to the cylinders, the valves being of the balanced piston type. They are 20in. in dia. and work in separate liners. Exhausting over the ends, these valves take steam at the centre through a 14in. double beat throttle valve placed close to them. The valve gear is of Joy's pattern, while the throttle valves are separately adjustable, although they can all be simultaneously operated by means of a steam-hydraulic reversing engine. The latter, of course, is essential in view of the heavy gear to be put in motion and the frequency of the operation necessary, and it is of the direct acting steam-hydraulic type very similar to that used on marine engines. The cylinder of this reversing engine is seen next the second column from the left.

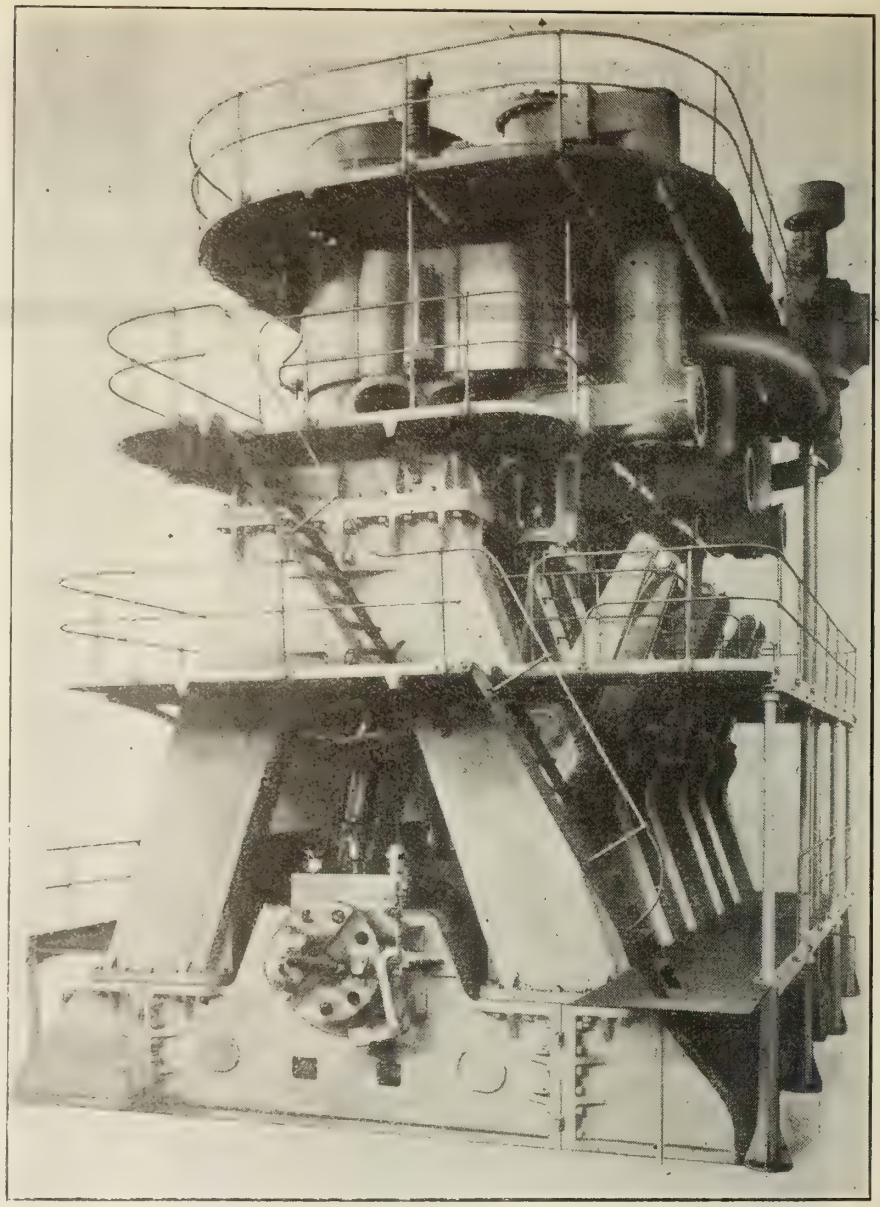
Built Up Crank Shaft

The crankshaft is built up of three sections, bolted together by flanges. Each of these sections consists of two webs and a pin forged out of the ingot, the two short lengths being shrunk on and pinned to the webs.

Both shafts and pins are hollow, being bored 5in. in dia. The body of the shaft is 22in. in dia. and weighs over 40 tons, but the whole was trued up in the lathe after being bolted together.

The main bearings are 24in. long and interchangeable. They are lined with white metal and water cooled. The connecting rods are of the orthodox marine forked pattern, the piston rods being 9in. in dia. and in common with the valve spindles are made of nickel steel. The pistons are steel castings machined all over. They rest on a collar on the rod, 8in. dia. steel nuts having a fine thread serving to secure them.

As ordinarily understood the engine has no governor but there is an emergency master valve in the main steam pipe. This comes into action when the normal speed of 140 r. p. m. is exceeded by 12% by means of a centrifugal weight on the end of which a trip level releases the hydraulic pressure which normally keeps the valve open.



End View.

Altogether the engine is an interesting example of a very powerful unit designed and built for exceptional duty. Needless to add in view of the very severe nature thereof everything had to be both simple and massive, while special facilities have been provided for inspection of the vital parts to be undertaken as easily as possible and any repairs effected with the utmost despatch.

The entablature which carries the three cylinders is built up of three castings two feet deep bolted together by deep flanges, the crosshead guides being also bolted to it assisting in tying the whole frame together. The cylinders themselves which have separate liners have cone shaped bottoms, forming little standards, inside which there is ample room for a mechanic to work at the stuffing boxes, the entry doors to which are seen just above the third platform.

A NEW CENTRIFUGAL PUMP

There are so many different types of centrifugal pumps in existence that it might seem impossible to invent another new type. Recently, however, a British firm introduced a special form adapted for marine purposes. In this service, owing to the rolling of the ship and to other causes, air is apt to be mixed with water in the suction pipe. The special feature of this new type, which is electrically driven, is that the air is first separated from the water, and afterwards both the air and the water are dealt with separately by properly designed pumps. When the water reaches the suction branch of the pump it is made to flow over a weir where most of the air is automatically released. This air is dealt with by a small reciprocating pump, while the centrifugal pump itself deals with the water. This pump has already been applied to motor ship service with conspicuous success.

Ladders and Stairways For the Power Plant

The Safety of Life and Limb Very Often Depends on the Proper Condition of Ladders, or Stairways—Some of the Principal Requirements of These Accessories Are Pointed Out

IN MEETING the needs placed upon the ladder, the character of material used in its construction varies from heavy angle steel or iron to a skeleton of wood—the degrees of permanency and the character of the load guiding in choice of materials and their fashioning.

Experience has dictated certain practices to be observed in building, placing, and using ladders The ladder should be of sufficient strength to resist safely double the strain of the heaviest load that will be placed upon it in use. This has been assumed to be about 450 lb.—the weight of a man and the burden he might reasonably be expected to carry up or down a ladder,—and a like weight added as a margin of safety. The ladder must be wide enough for the user to move freely and safely about his work.

A stationary ladder is one that is so anchored or fastened, permanently or temporarily, to a structure or piece of mechanism as to become a fixed part therefore. A portable ladder is one that is to be used transiently at various locations, and may have various forms, such as:—

A step-ladder so constructed as to be self-supporting; a sectional ladder of two or more sections so constructed that the sections will telescope one into another, or so arranged as to be united into a single ladder; a trolley ladder having a movement confined in permanent guides or ways at top or bottom, or both; a trestle ladder whose parts, each equivalent to a straight ladder, are hinged at the top to form A frames.

Clearances

In placing a stationary ladder, a continuous clearance space should be provided, back of the ladder rungs, such as to allow a man's foot to obtain a fair purchase on the rung, as a slight obstruction to the foot or hand in gaining a hold on a rung may cause a mis-step, with serious results. For this reason, general practice favors a minimum clearance of 8 in. and some authorities favor allowing a minimum of even 12 in. Continuous clearance space should be provided in front of the ladder, so as to allow a person to assume a free and natural climbing posture. Fixed objects projecting at random too close to the front of a ladder may strike and injure the person climbing, or they may catch the clothing of the climber and jerk him loose from his hold. To eliminate such a hazard, some requirements provide for a minimum clearance space of 24 in., but 30 in. to 36 in. seems to be more generally favored, because a workman often carries tools projecting from his pockets or tool belt that would not pass a 24 in. clearance. It is evident from the foregoing discussion that it is important to have a proper continuous clearance space of 15 in. on each side of the centre line of the ladder. If ladders are used as a common passage-way, provide one or more for ascending and another group for descending.

Material for Ladder

Permanent stationary ladders should be constructed of steel or iron and should be designed effectively to resist the impact blows of falling materials and loads swinging from cranes and hoists. Ladders having side rails and fastened top and bottom, with intermediary supports, are preferable to the built-in type consisting of U-shaped sections embedded in a wall or fastened to a shack. Side rails of angle steel or iron should not be less than ¾ sq. in. in cross-section, a size of 2 in. by ½ in. being preferred.

Ladders designed to reach safety valves, cut-outs, etc., where speed of operation may mean a saving of life, should always be of permanent type, securely fastened and constructed entirely of steel or iron.

Safe practices, applying to stationary or fixed ladders, include the following: When sections join, splice plates shall be of the same size and material as side rails, and carefully riveted or bolted. Wooden ladders may be spliced with steel braces of equivalent strength. Ladders over 20 ft. in length should be built in zig-zag sections and provided with safety platforms, no open space of over 18 in. being allowed back of the landing Brackets should be of suitable strength to support firmly the ladder and weight of workman and burden, and should be of sufficient rigidity to resist any anticipated impact from falling material or traveling crane. They should be fastened by through or expansion bolts firmly embedded in the wall, and should be spaced not over 12 ft. apart.

Temporary and portable ladders are usually constructed of wood, thoroughly seasoned long-leaf yellow pine, Oregon fir, or northern white spruce giving good results for side rails, and white ash, oak (second growth), or hickory for rungs. All material should be free from knots or shakes, although half-inch imperfections are sometimes allowable in side rails of the larger sizes of ladders if in centre of stringer.

The rungs should be designed as a simple beam supported at both ends to resist safely, without permanent or readily apparent deflection, the stresses incurred by a load equal to the weight of an average man imposed at the centre of the rung, plus any weight carried or supported by a man on the ladder. The minimum section of a rung should be a diameter that provides the most secure hand-hold. Having all the rungs in a ladder of uniform section is good, as it eliminates the annoyance of varying the grip with each rise. Rungs of a ladder should be free from splinters if wood, and burrs if steel, as experience has shown that it is such small annoyances to the climber that cause many a mis-step and fall; spacing of rungs should be uniform. General practice favors a string spacing varying 15 in. to 18 in., for metal construction a round steel or iron rung varying from ⅝ in. to 1 in. diameter, and for wooden construction a rung not less than 1⅛ in. in in diameter, and for wooden construction a rung not less than 1⅛ in. in diadiameter, tapered to fit a somewhat smaller socket. Excellent wooden rungs are made from blocks sawn to proper length. If of white oak, blocks may be split and hand-shaved to size and the ends machine-turned to fit sockets in stringers. Hickory or white ash will not split evenly and machine-turning will be necessary; consequently, careful selection should be made of material and careful inspection and testing made to avoid weak rungs.

Safety Bases and Tops

For wooden floors, metal points or lead-coated bases are recommended; for concrete floors, pivoted lead shoes or carborundum: for wet floors, recessed rubber bases have given the best satisfaction. For use on iron floors, carborundum has been found to serve very well, but Pennsylvania specifies the placing of an attendant at the foot of each ladder when working on iron floors. We cannot depend on any one type of base under all conditions and be safe.

Safety tops are provided for fixed ladders by omitting rungs above the highest work level, running the sides shoulder-high above that level. A "goose-neck" permits a higher degree of safety. Oilers' ladders, with hooked tops to fit over shafts, are becoming more and more the rule.

Convenience limits the length of portable ladders to approximately 30 ft. Ten-foot ladders, constructed of northern spruce side rails (or wood of similar strength) will be found satisfactory if of 1⅜ in. by 2⅜ in. material; 18 ft., 1⅜ in. by 2¾ in.; 25 ft., 1⅝ in. by 3 in.; 30 ft., 1⅞ in. by 3½ in. Rungs of 24 in. length seasoned ash should be 1⅛ in. diameter, with tenon of ⅞ in.; over 24 in. long, 1¼ in. diameter, with tenon of ⅞ in. Width at the bottom of most types of portable ladders should be appreciably greater than at top. Figs. 2 and 3 show good practice for fastening rungs to stringers. If the rung is inset in a binder strip and screwed to

the stringer with a wood screw through each rung, a safe and satisfactory construction will be reached.

Step-ladders should never exceed 20 ft.. in length, and have side rails from ⅞ in. by 3 in. to 1 in. by 4¼ in., the latter being used as the limit of length is approached. Steps vary from ¾ in. to 1 in. thick for the heavier types, and a slight increase in width is also recommended in very long ladders over the 4¼ in. of the shorter ladder. For every foot of length the bottom of a step-ladder should be 1½ in. wider than the top. Steps must afford a safe foothold, should be trussed, braced, or reinforced, and must be securely screwed or bolted to side rails.

Safe Practice

Use care in placing ladders. Do not place ladders too straight or at too great an angle, or they may fall, break, or slip. Never place ladders in front of doors opening towards the ladder. Ladders should never be placed against window sashes. Screw a board across the top of ladders to give bearing at each side of the window.

Step-ladders should be fully opened out in all cases before anyone steps on them. Always face ladder when ascending or descending. Do not go up or down a ladder without free use of both hands. If material has to be handled use a rope. Short ladders should not be spliced together, as they are not built strong enough to be used as long ladders.

Ladders should be kept clean and free from dirt or splashings of paint or material. Imperfections or defects are not readily observed unless ladders are kept in good condition. Iron and steel ladders should be coated with a preservative paint or composition. Wooden ladders, if used out of doors, should also be carefully treated with a suitable preservative, such as varnish or oil. Do not paint wooden ladders.

Safety belts and hooks should be provided when the character of the work demands the attention of the workman or constitutes an element of danger.

Stairways.

Ramps, used as a means of ascending or descending from one level to another if the grade is less than 20 deg. from the horizontal, should be rigid, with unobstructed passageway, bolted together. Cleats should be spaced about fourteen inches apart, and should extend from guard rail to guard rail, at right angles to the line of travel, except where a runway is necessary for wheelbarrows or trucks. Splinters, nails, patches, irregularities, breaks, or cracks in walking surfaces are dangerous, and should not be tolerated.

Ramps with granolithic or cement walking surfaces should have walking surfaces made anti-slip by rough floating, or by incorporating 1½ lb. per sq. ft. of abrasive grit, such as alundum in the mix for finish coat, and then sprinkling another 1½ lb. per sq. ft. over the surface before giving the rough float. Others prefer the use of in.-wide strips of anti-slip tread set 10 in. on centres in the cement at right angles to the line of travel and projecting less than ⅛ in. above the surface.

If the grade is greater than 20 deg. and less than 50 deg. from the horizontal, stairs should be used. Fixed ladders are necessary for grades over 50 deg.

For long stairways, landings between floors are desirable, dividing into approximately 12 ft. sections. Avoid doors opening on stairs, and provide landings sufficiently large to afford safe standing room outside of the space required by swing of door. Glass panels in doors opening on landings are necessary for safety, especially when swinging doors are used.

Treads

Stair treads and landings should be of sufficient strength to bear the maximum number of people that can stand upon them. Building codes generally require that the stair shall safely carry a load of 100 lb. per sq. ft. at the usual safe working stresses.

Width of treads and height of rise should be uniform for each flight of stairs, the tread giving ample width on which to place the full length of the foot when descending without danger of striking the heel against the riser above, but not so wide as to compel an increased stride. It is good practice to make the tread width (exclusive of nosing overhang), plus twice the riser height, equal to 25 in. In using this rule the thickness of the tread should be added to the height of the riser. The tread width should be further increased with a nosing overhang of ⅞ in. to 1¼ in., with the under edge rounded or bevelled.

Iron or steel treads are unsafe, as slipping is possible at all times. Under ordinary conditions marble, slate, wood, and other materials are safe, but mud, oil, or wear may render them unsafe. The safe type retains an effective and anti-slip quality for long periods even under exceptionally severe traffic. To this class belong cork, asphalt mastics, iron-abrasive, and lead-abrasive types of anti-slip treads. Concrete treads are sometimes used with anti-slip tread inserts to protect nosing from chipping, to prevent people from slipping, and take all the wear on an easily replaceable insert. Sometimes they are roughened by floating abrasive crystals into the setting concrete.

Height of the rise in conjunction with the width of tread determines the angle of the stairs, which should be between 30 deg and 36 deg. from the horizontal.

When the stringers of stairs do not accomplish the purpose, toe-boards should be added to fit snugly to the sides of treads and risers, and extend not less than 3 in. above the nosings. When stairways or runways are used for transporting materials a wire mesh guard should be filled in from toe-board to handrail.

Stairways 3½ ft. or more in width should have a handrail on each side. Open stairways, regardless of width, should have handrails on both sides, and stairways over 7 ft. in width should have handrails on both sides and in the centre. Measured from the centre of the tread the handrail should be about 42 in. high, because the average adult accidentally falling against the railing will strike with his weight under rather than above the rail. If the rail is properly braced, it will take up the force of the impact, and the intermediate rail will prevent the workman falling outside of the stair or runway. A young person would be saved from falling by the intermediate rail, which should be provided about midway between the toe-board and the upper or handrail.

Steel or iron angle or pipe is the best material if the railings will be subjected to strain, though wooden rails, if straight-grained and free from knots, imperfections, and splinters, are sometimes used when the traffic is light.

Rails made from angle iron or steel should have chamfered edges, an even, smooth surface, and the ends rounded or flush with upright. Supporting posts should be finished in a similar manner. 1¼ in. to 1½ in. pipe, with malleable fittings counterbored sufficiently to extend at least ¼ in. beyond threads on pipe, or 2 in. by 2¼ in. angle-steel for top rails and ¼ in. by 2 in. flat for intermediate rail; or 2 in. by 4 in. wooden top rail and 1 in. by 6 in. intermediate rail, will provide safe conditions. When metal handrails are used, supporting posts or braces should be spaced not more than 12 ft. apart. The railing will be stronger and safer if riveted instead of bolted together. In wooden construction it will be found advisable to space posts not more than 8 ft. from centre to centre to ensure rigidity. Supporting posts and braces should be of the same or larger dimensions than the railings. Handrails of enclosed stairways should extend about 3 in. from the wall to provide space for the hand to grip the railing and avoid scraping the fingers on the wall.

Circular stairways should be avoided in new construction. Existing circular stairways with narrow treads should be closed to all except employees whose work makes it necessary to use them. When circular stairways are necessary, variation in the width of tread should be avoided as far as possible, and effective and durable anti-slip should be used. Warning signs should be displayed at both top and bottom of such stairways.

Arrangement

Stairways located in dark places should have ample artificial light provided, so shaded as to throw the light on the stair and not in the eyes of the users. Especially good light should be provided at the commencement of each flight, at landings and platforms, so that the first tread and riser are clearly visible, as they are more important than the intermediate steps. Sufficient head room should be obtained, the ver-

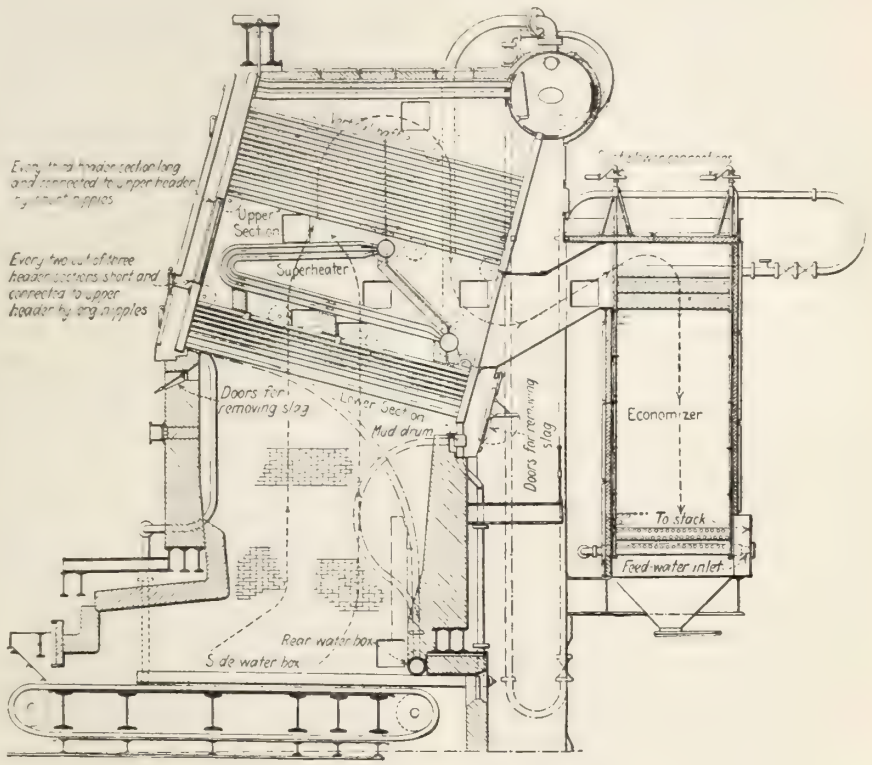
(Continued on page 24)

Very High Pressures in Modern Practice

Central Station Plant of Public Service Company Uses a Boiler Pressure of 400 Lbs. Per Square Inch, Marking a New Advance in Engineering Practice on the American Continent

DURING the last few years there has been a distinct tendency in central-station engineering toward increasing the operating steam pressures. As a notable example of this tendency may be cited the new power station of the Public Service Company of northern Illinois, now being erected at Waukegan, about 40 miles north of Chicago.

The Waukegan station has been designed by Sargent & Lundy, Inc., engineers, and the steam pressure will be 400 lb. at the boilers—350 lb. to 375 lb. at the turbines. There are a few small experimental or test plants running intermittently at such pressures, but this will be the first central station in this country to employ a boiler pressure in excess of 350 lb., and the boiler that will be used embodies a radical departure in the matter of boiler design. The boilers are being built by the Babcock & Wilcox Company. They are entirely different from any B. & W. boilers thus far used and represent a boiler that has been developed by the engineers of that company working in conjunction with the engineers of Sargent & Lundy over a period of two or three years, with a view to obtaining a boiler that will be suitable for considerably higher pressures.


Every third header section long and connected to upper header by short nipples
Upper Section
Every two out of three header sections short and connected to upper header by long nipples
Superheater
Doors for removing slag
Lower Section
Mud drum
Doors for removing slag
Economizer
To stack
Feed water inlet
Rear water box
Side water box

View showing position of superheater and path of gases.

Small Individual Elements Essential

It has been recognized that in the design and construction of boilers for pressures in excess of 350 lb. the volume of individual elements of the boiler-pressure parts must be smaller than were formerly used in order that the failure of any single element shall not result in serious destruction. Further, small individual elements make possible the use of metal thicknesses for pressure parts of the high-pressure boiler no greater than, if as great as, that of the larger elements ordinarily used in the construction of boilers designed for ordinary pressures, and the difficulties that migh arise from excessive thickness of metal exposed to heat and pressure are thus obviated.

The general features of design of the combined boiler, superheater and economizer unit as finally adopted for Waukegan are indicated by the accompanying illustration. The position of the superheater and the path of the gases are particularly novel.

These new Babcock & Wilcox boilers are of the inclined header design, thirty-four sections wide, the sections being double-deck and connected to 54-in. cross drums. The lower sections are made up of eight 3¼-in. tubes, the tubes being 15 ft. long. Each upper section is composed of seventeen groups, each of two 2-in. tubes of the same length. The 3¼-in. and the groups of 2-in. tubes are so arranged and spaced that there are access lanes between all tubes horizontally and in two directions diagonally. The tubes of the lower sections are exposed for their full length to the direct radiant heat of the furnace, this portion of the boiler being constructed without baffles.

On account of the high superheat required, and also to avoid superheater being of excessive size, it is installed between the 3¼-in. tubes and the 2-in. tubes and is composed of three rows of 2-in. superheater loops.

Provision is made for removal of superheater tubes by connecting two of each three upper and lower section headers by long nipples and the third of each three sections having upper and lower headers by nipples which are shorter.

The gases pass from the furnace over the lower sections, which, as stated, are without baffles; thence over the superheater and into the upper deck, which is equipped with a single baffle, making this portion of the boiler two-pass. The gases are taken from the boiler through the long nipples connecting the upper and lower rear headers and are led to the top of an economizer at the rear of the boiler setting.

With the fuel to be burned and at the capacities that will be developed, there will be some tendency toward the formation of slag on the tubes of the lower section. Provision is made for the removal of such slag from the forward part of the lower tubes through special doors below the uptake headers, and at the rear through special doors opposite the nipples connecting the downtake headers to the mud drum, it being possible to use a "pokerod" between these nipples.

The superheater chamber is such that there is ample room for access above, below and between superheater loops and at the rear, below the second pass, to the superheater headers. This arrangement gives ample opportunity for periodical inspection and for thorough cleaning.

The economizer, placed at the rear of the boiler setting, is of the Babcock & Wilcox transverse-tube "Duratex" design and is built for a working pressure of 450 lb. It is thirty-six sections in height, each containing twenty 2-in. tubes, 20 ft. 10 in. long, connecting 7¼-in.-square wrought-steel economizer headers. Feed water enters the lower header at one side of the economizer and passes through a single row of tubes to the corresponding header on the other side. From this header the feed passes through a second row of tubes to a second header on the feed-inlet side of the economizer, and in a similar manner through all sections in series from the bottom to the top. This design with the downward passage of

gas and the upward passage of water through the economizer results in strict counterflow of water and gas which is essential for the best heat absorption, and the counterflow principle, together with the gas and water velocities employed, leads to maximum heat-transfer rates and corresponding maximum economizer efficiency.

Each boiler contains 14,086 sq. ft. of surface, the superheater 2,485 sq. ft. and the economizer 8,837 sq. ft. This boiler unit is designed for a normal output of 100,000 lb. to 120,000 lb. of steam per hour and a maximum of 150,000 lb., the steam to be superheated to 700 deg. Fahr.

Forced-Blast Chain Grates

The boilers, which are set with a 21-ft. 7 in. furnace height, are fired under the intake end and are equipped with Babcock & Wilcox forced-blast chain-grate stokers, each 21 ft. wide by 18 ft. 3 in. long, giving a grate surface of 383 sq. ft. and a ratio of grate to boiler-heating surface of approximately one to thirty-seven. The chain grates are equipped with side-wall and bridge-wall wrought-steel water boxes connected to the circulation of the boiler.

The engineers of the Babcock & Wilcox Company consider this design to be a great stride forward and think that it will be one of the most efficient boiler units yet developed, irrespective of pressure. Three of the complete Babcock & Wilcox units as described have been purchased for the Waukegan station, and three units of the same section, though not so wide, for the Grand Tower station of the Middle West Power Company, for which station Sargent & Lundy are also the engineers.

COAL ANALYSIS

The results of analyses of hundreds of coals from 25 states and the Territory of Alaska are given in Bulletin 193, "Analyses of mine and car samples of coal collected in the fiscal years 1916 to 1919," by Arno C. Fieldner, Walter A. Selvig, and J. W. Paul, just issued by the United States Bureau of Mines. Information as to the heating values of all coals tested is also given in the bulletin, which should be of interest to all extensive users of coal fuel.

Many mine samples of coal are analyzed each year in the laboratories of the Bureau of Mines. The analyses are made in connection with investigations relating to fuels belonging to or for the use of the United States Government, the causes of accidents in coal mines, the geologic relations of coal beds, and the quality and the value of the coal and lignite in the public lands. The systematic collection and analysis of such samples in connection with fuel investigations was begun in 1904 at the Government fuel-testing plant at the Louisiana Purchase Exposition, and was under the direction of the United States Geological Survey for six years. Descriptions of the coal samples collected between the beginning of this work, July 1, 1904, and the transfer of the fuel-testing and mine-accident investigations to the Bureau of Mines, July 1, 1910, were compiled and published in Bureau of Mines Bulletin 85. Descriptions and analyses of samples collected during the fiscal years 1913 to 1916 were published in Bureau of Mines Bulletin 123.

In order that the material in this bulletin may be used to supplement that presented in Bulletins 22, 85 and 123, the same plan of geological classification has been followed, the analyses and descriptions of the samples being grouped in alphabetical order according to States, county and town near which the mines or prospects sampled are situated.

Information regarding coal sampling and analytical methods employed by the Bureau of Mines and a bibliography on the coal resources of the world are contained in the bulletin.

The entire distribution of Bulletin 193 will be through the Superintendent of Documents, Government Printing Office, Washington, D. C., from whom the report may be obtained at a price of 35 cents. Bulletins 22, 85 and 123, the previously issued compilations of coal analyses made by the Bureau of Mines, are sold by the Superintendent of Documents at prices of 85, 45 and 50 cents, respectively.

POWER EXPOSITION AT NEW YORK

Engineers well known in industrial and public utility power generations make up the Advisory Committee which is guiding the National Exposition of Power and Mechanical Engineering. This exposition will open at the Grand Central Palace, New York City, on December 7th at noon and will extend through to December 13 (except the intervening Sunday). It will immediately follow the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers. Irving E. Moultrop, of Edison Electric Illuminating Co. of Boston, heads the Advisory Committee, and his colleagues are: Dexter S. Kimball, president of the American Society of Mechanical Engineers; Alexander G. Christie, chairman Power Division A.S.M.E.; Fred Felderman, national president National Association of Stationary Engineers; Milan R. Bump, president National Electric Light Association; N. A. Carle, vice president, Public Service Production Company of New Jersey; E. B. Katte, chief engineer, Electric Traction, N.Y.C. R.R. Co.; Fred R. Low, editor "Power"; David Mocat Myers, consulting engineer; Calvin W. Rice, secretary The American Society of Mechanical Engineers, and the managers, Charles F. Roth and Fred W. Payne.

This Advisory Committee is keenly alive to the importance of an exposition that will stress the engineering phases of the problems involved in the economical uses of fuel and the more effectual generation and utilization of power. The effect of such an exposition must be far-reaching and the plan outlined by the Committee insures a show that will benefit the manufacturer who uses only a small boiler for process steam as well as the engineers of the great cement, ceramics, metallurgical and power generation industries, whose fuel and power problems are extensive and severe.

The list of firms who have already reserved space shows that all apparatus and materials used in harnessing the energy released from fuels will be represented. The general appreciation of the importance of the exposition further insures the showing of the newest devices and best methods.

The program for the week has been arranged so that those interested especially in fuels and power can attend the technical sessions on these subjects at the annual meeting of the American Society of Mechanical Engineers. Sessions on Ash Handling Machinery, Stokers and Steam Utilization have already been announced; others are to come later and it is probable that the papers on these subjects will be amplified by the exhibits at the Exposition.

All members of the American Society of Mechanical Engineers who attend the meeting will receive the half fare return certificate which will enable them to attend the Exposition. Details of the certificate plan will be issued at a later date in the publications of the A.S.M.E.

The educational functions of such an exposition cannot be overemphasized. Not only is the contact between the purchaser and manufacturer of power plant equipment strengthened but there is the advantage of being able to compare displays and to choose that which is suitable and desirable.

LADDERS AND STAIRWAYS FOR POWER PLANTS

(Continued from page 22)

tical clearance being not less than 7 ft., measured from top of tread on a line with face of riser.

When the stairway ends in direct proximity to a crane runway, dangerous machinery, running belts, shafting, or traffic hazard, strong detour guard rails should be built and well braced to deflect traffic from the hazard. The floor at the head or foot of a stairway should be not less than 4 ft. from the nearest top or bottom riser.

No obstruction of any kind should be allowed in passageways leading to fire escapes, or on balconies, platforms, stairs, or landings of escapes. Each outside runway or stairway should have a cover or roof to keep off snow and ice, or if a cover is not provided, snow and ice should be immediately removed.

Combustion For the Boiler Room Operator

The Formation of Carbonic Acid, and Carbon Monoxide in the Furnace Gases is Discussed, and the Proper Proportion to be Aimed at, and the Reason, is Explained

By T. H. FENNER

IT WAS assumed in the last chapter that the fire had been started with clean grates, and had been built up to a proper operating thickness. We can further assume that the damper is set to create just the right amount of draught, and that we are getting the correct amount of air for proper combustion. In other words conditions are just about perfect. The process of combustion is the rapid combination of the carbon and hydro carbons of the fuel with the oxygen of the air, attended with the development of intense heat. Now we have seen that the air contains 21 parts of oxygen and 79 parts of nitrogen in every 100. When perfect combustion occurs, the carbon in the fuel and oxygen in the air unite in the proportion of one atom of carbon to two atoms of oxygen, forming a mixture which the chemist calls CO_2, or in ordinary language carbonic acid gas. Some of the hydrogen will combine with the oxygen in the coal to form water. A little explanation of these chemical changes will help the non-chemical reader to more readily grasp the idea. We have spoken earlier in these articles of the atomic weight of gases. Now just as specific gravity of any body is the ratio of its weight compared to the weight of an equal body of water, so is the atomic weight of any gas the ratio of the weight of its atoms compared to those of hydrogen gas. The specific gravity of water is 1. All other bodies will have a specific gravity of more than one or less than one. Hydrogen being the lightest known gas, its atomic weight is called 1, and the atomic weight of the other gases are multiples of one. The atomic weight of carbon is 12, while that of oxygen is 16. Thus in a molecule of water there will be a total atomic weight of 18, made up of two atoms of hydrogen, weighing each 1, and one atom of oxygen which having of weight of 16, makes a total of 18. The chemical formula is H_2O which means that there are two atoms of hydrogen and one atom of oxygen. In the same way CO_2 means there is one atom of carbon, and two atoms of oxygen, the atom of carbon of carbon having a weight of 12, and the two atoms of oxygen having a weight of 32, the total weight of the molecule being 44. If the carbon and oxygen combine in the ratio of one to one, forming CO, or carbon monoxide, the weight will be only 12 plus 16, or 28. We are not particularly interested in the matter of atomic weights, except so far as knowing just what we mean when we allude to CO_2, H_2O, and similar symbols.

When the oxygen in the air and the carbon unite in the ratio of one of carbon to two of oxygen, and form the mixture known as carbonic acid gas, or CO_2, the heat evolved by the chemical combination is 14,600 B. t. u. If insufficient air is supplied so that combustion is incomplete, and the carbon only combines with one atom of oxygen, the resulting combination, is carbon monoxide, or CO, and the heat evolved is only 4,400. We thus gather the idea that there must be two stages to combustion, a stage in which the combination is only partially performed, and a further stage in which the reaction is completed. The first stage is attended with only a small evolution of heat, and the second one with a much greater evolution. We can now trace these two stages in the fire which we have kindled in imagination.

We have then a bed of glowing coal, part of which is solid carbon, the lighter gases having been distilled off, and ignited by the heat of the refractory furnace lining. The air to support the combustion of this solid carbon must be passed through the fuel bed from the bottom up, as there is a greater pressure in the ashpit than there is over the fire in the furnace. We shall assume that in the condition prevailing in the furnace the fuel bed is of equal thickness throughout its length and breadth, and that the air will enter and pass through at all points with equal facility. The air in passing through the fuel bed, mixes intimately with it, and the carbon unites with the oxygen, each carbon particle being affiliated with two oxygen particles and the mixture of carbon, oxygen and nitrogen passes on through the setting, giving up its heat to the heating surfaces of the boiler as it moves over them.

Composition of Flue Gas

Now we can see what will be the make up of the gases leaving the boiler, knowing that what entered was simply nitrogen and oxygen, in the proportion of 79 to 21. We know that in the passage through the fire a certain amount of the oxygen combined with the carbon, and formed CO_2, so that we should naturally expect to find on analysis, that we had CO_2, nitrogen and oxygen. That is all right, but what proportion of each should we have? Now we are getting right down to the question of flue gas analysis.

Remember that in the case we are using for illustration, we have assumed a very clean even fire, and a supply of air thoroughly mixed with the fuel and should expect to get very good results. We shall then assume that the gases being analyzed, showed a percentage of 14 CO_2, and we congratulated ourselves on the fact. We did not bother to find out what proportion of the remaining 86% was oxygen or nitrogen, or whatever else it was, but were contented with the knowledge that the carbonic acid gas in the flue gases was equal to 14% of the total.

Now there is a peculiar property about the mixture of oxygen and carbon to form carbonic acid gas. It is that although there has been a combination of two different elements to form a new gas, the volume of the new gas is just the same as the volume of the original oxygen. That is, if we have 100 cubic feet of air, which is 21 c. f. oxygen and 79 c. f. nitrogen, and we pass this through the furnace, obtaining perfect combustion, this is what would take place. There would be just enough oxygen present to combine with the carbon, so that out of the 100 cubic feet, 21 cubic feet of oxygen would be changed into 21 cubic feet of CO_2, and the balance would be nitrogen. We must qualify this further, and say that if the fire was composed of pure carbon, and perfect combustion took place, with just the right amount of air, the resulting gases would be composed of 21 per cent. CO_2, and 79 per cent. nitrogen.

This then shows us that there is a definite ideal at which to aim, namely, 21% CO_2, but we have expressed ourselves as being well satisfied with the result of 14%. This is surely a great difference between theory and practice. Well, at first sight it looks that way, but we shall see that the difference is easily accounted for.

In the first place, the fuel in our furnace will not consist of pure carbon, and in the second place it is an utter impossibility to use exactly the right amount of air to ensure perfect combustion. We have to use more than enough in order to ensure getting quite enough. Thus we have two conditions which immediately destroy the ideal.

When we were discussing the quantity of air required to burn one pound of coal, we found that it was about 11.5 lbs. theoretically. In order to get the thorough mixture that is necessary we should have to use from 18 to 23 lbs. in actual practice. What effect will that have on the products of com-

bustion? Well, although there is just the same amount of carbon present to combine with oxygen, there will be double the amount of air present to supply that oxygen. It is obvious then that the percentage of CO_2 in the flue gases will be lower when we use a larger quantity of air than when we use just the required amount. To show the result in figures, suppose that instead of 100 cubic feet of air that we mentioned previously we now have 200 cubic feet, but the same quantity of fuel. The gases leaving the furnace then will be 21 parts of CO_2, but there will be 179 parts of nitrogen and oxygen not in combination. That is there are 100 parts more air than there was formerly, and the percentage of CO_2 wil now be

$$\frac{21 \times 100}{179} = 11.7\%$$

instead of 21 per cent. as before. This is the explanation of why excess air gives low CO_2. The products of combustion, when there is large quanity of excess air present, are diluted and instead of a rich mixture of CO_2 and a comparatively small amount of nitrogen and other gases, there is a weak mixture of CO_2 and a large proportion of nitrogen and free oxygen. CO_2 then is a positive measure of excess air, and that is where the value of gas analysis becomes apparent. CO_2 itself is a good guide, but when measured in conjunction with the proportion of oxygen or CO in the gas, it becomes a perfect pointer out of conditions.

Why should this excess air be detrimental to boiler efficiency? Well, as already stated, every pound of air that enters the furnace has to be raised in temperature by the combustion of the fuel, and this heated gas then gives up its heat to the water in the boiler through the heating surfaces. Now if large quantities of air are passed through the furnace over and above the amount necessary for good combustion, it is obvious that with a given quantity of heat available, the temperature of the gases will be lower than if a smaller quantity were used. Then we have a large quantity of gas at lower temperature. Another effect is present, and that is, owing to the much larger volume of gas, it has to attain a much higher velocity in passing through the boiler setting, the result being that a large quantity of the heat is carried away before it has a chance to pass through the heating surfaces. Thus we see that low CO_2, caused by excess air, causes a lower temperature in the furnace, but at the same time is usually accompanied by a higher temperature in the chimney gases, showing a larger amount of heat carried off up the stack.

We must admit then that we cannot hope to get our ideal CO_2 because of the necessity of passing excess air through the furnace, but we should try and keep this excess air down as much as possible. Another thing that will prevent us from getting the theoretical possible CO_2 is the composition of the fuel itself. It is obvious that if the fuel consists of only 70 to 80 per cent. carbon, that the mixture of carbon and oxygen will be lower than 21 per cent. For instance, if the fuel contains a certain amount of hydrogen, this hydrogen will combine with the oxygen in the coal itself in the proportion of 1 part hydrogen to eight oxygen and form water. This will cause the percentage of the carbonic acid gas in the total gas to be less than if the fuel had been all carbon. Therefore, we can see that when we got 14 per cent. CO_2 we were doing very well, as a practical proposition. Suppose that instead of passing too much air through the furnace we had passed too little. We should then have found a low percentage of CO_2 in the flue gas analysis. We should have also have noted a low temperature in the furnace, just as when we had too much air, but we should most likely have found the temperature of the chimney gases low also. In the case of low CO_2 in conjunction with too much air we found a low furnace temperature, but high chimney gas temperature. When we get low CO_2 through insufficient air, we get low furnace temperature, but also low flue gas temperature.

It is evident that both too little and too much air will give us low CO_2 readings, but by giving due attention to the other phenomena accompanying the low reading, we can diagnose the cause fairly well. We may say that the greater number of cases of loss of fuel through low CO_2 is due to excess air, and not to lack of sufficient air. There are so many places where air can find its way into a setting, that there is but little chance of there being a shortage under ordinary conditions.

If a shortage of air does occur, it means that instead of the carbon burning into carbon dioxide and developing 14,600 B. t. u. per lb. the reaction is only to carbon monoxide, developing 4,400 B. t. u. per lb.

If we get too much air we shall have highly heated gases passing up the stack without benefit to the boiler, causing immense losses of coal. If we get too little air we shall have large quantities of unburnt coal passing up the stack, causing large losses of coal. Evidently this question of getting the right quantity of air is something worth looking into. There is no method of checking furnace conditions so good as a proper use of flue gas analysis in conjunction with proper checks on temperatures.

The progress of events when CO is formed instead of CO_2 is, first, the air passes up through the burning coal on the fuel bed, and CO_2 is formed. When the carbonic acid gas passes through the fire, and into the combustion chamber, it meets more unburned carbon and each molecule of CO_2 takes up another atom of carbon, thus making two atoms of carbon to two atoms of oxygen, or C and O in equal proportions, CO.

When too much air is admitted, perfect combustion may be taking place, but owing to the large masses of inert gas or nitrogen that have to be heated, a large heat loss ensues, as already explained.

It is possible with a hand gas analyser to obtain the percentages of carbon dioxide, carbon monoxide, and oxygen, in the flue gases, but as a general rule, in ordinary practice, if the proportion of carbon dioxide is right, the other gases can be neglected. It is obvious that if the carbon dioxide is low through insufficient air, then there will be a large proportion of CO present in the gases, while if the CO_2 is low through too much air, the proportion of CO will be slight, but oxygen will be high.

It is possible to get CO even when CO_2 is good, but as a rule it will be only in very small quantities, and it is difficult to avoid. If you are getting from 12 to 14 per cent. CO_2, there will be but little cause to worry over the possible presence of CO, and if you admit more air to counteract the CO, you are going to lower the temperature of the furnace, and also the proportion of carbon dioxide. The operating engineer will find it pays him to confine his attention to getting the maximum possible CO_2, and letting the rest take care of itself.

Hand Gas Analysers

For taking samples of gas from different boilers and different parts of the same boilers, the hand gas anaylser of the Orsat type is a convenient and inexpensive instrument.

It consists of a measuring burette, or glass chamber, with suitable graduations, and three smaller glass chambers or pipettes, with which communcation is made by means of a tube, having a branch to each pipette. Each of these branches has a pinch catch on it, so that the tube and branches are like a steam header with three branches, and a valve on each branch. The end of this main tube or header goes to the sampling pipe in the boiler setting, and there is a main valve to close off the tube after the sample is taken. The gas is drawn through into the measuring burette by means of an aspirator, usually just the ordinary bulb such as is used in a syringe, the air all being expelled out of the burette and tube, and the gas rushing in to fill the vacuum when the pressure on the bulb is released. As soon as the sample is drawn into the meauring burette, the communication with the boiler is shut off, and three branch valves have of course been shut off all the time. There is thus a sample of gas filling the measuring burette and the tube. At the bottom of the burette is a tube communicating with a bottle filled with water and open to the atmosphere. This bottle is elevated, and the water runs into the burette, compressing the gas, until the

water in the burette reaches the zero mark on the scale. The leveling bottle should then be at such a height that the level of the surface of the water in the bottle and the zero mark on the burette are at the same height. There is thus a definite quantity of gas at atmospheric pressure in the burette. The pinch cock on the branch leading to

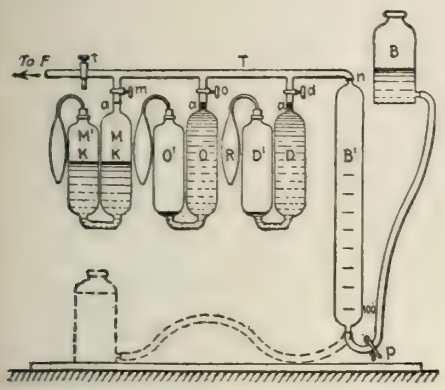


Diagram of Orsat Gas Apparatus.

the first vessel is now opened, and the filling bottle raised higher, so that the gas is forced into the first pipette. This contains a solution of caustic potash which possesses the property of absorbing CO_2. The gas is held in the pipette for a few seconds, and then the bottle is lowered, the water level in the burette as it falls drawing the sample of gas back from the first pipette. As soon as the water has reached the zero mark or a bit below it, the branch cock to the pipette is closed. The levelling bottle is then again raised, until the two levels are once more equal. Owing to some of the gas having been absorbed, there is less volume and the levels will be higher. The scale is graduated to read directly in percentages, and the more gas absorbed, the higher will be the level and the higher CO_2. If determinations of CO or O are required, the sample can be passed through the other two pipettes in order, in the same manner as the first one was. The absorbing material for the oxygen is a solution of potassium hydroxide, and pyrogallic acid. The absorbing medium for CO is cuprous chloride.

Care should be taken when first taking samples that all the air is removed from the tube and burette, and that the sample represents flue gases only.

The sampling pipe should be placed so that it is the centre of the last pass in a water tube boiler, and about the centre line of the tubes close to the head in a h. r. t. boiler. Perforated tubes are not recommended, an open ended pipe being better, care being taken that the opening is in the path of the gases.

All CO_2 recording machines are founded on the same principle as the Orsat, but being automatic, suitable mechanism is built into them to operate the pencil that marks the chart. The gas is usually drawn through the machine by a constant stream of water or a steam aspirator.

Temperatures

If conditions of combustion are good, we should have over the fire a temperature of about 2,000 degrees. This will decrease if the heating surfaces are in good order, and no leaks are present in the brickwork, to about 550 degrees in the base of the stack, or the blast pass as the case may be. The only way to get furnace temperatures is by means of a pyrometer, and this is not an ordinary instrument found in the boiler room. Flue gas temperatures are obtainable by means of a special thermometer of the portable type, or a recording thermometer such as manufactured by several makers. If the flue gases go much above 600 degrees, it is usually an evidence of too much air, unless the boiler is being worked at high ratings. High ratings involve intensive combustion, with very high temperatures, and the usual result is a much higher temperature in the flue gases, although the efficiency may be but little less than with the ordinary rating. It pays to lose a little efficiency owing to the saving in first cost and fixed charges, etc., by installing a smaller boiler plant, which can be forced up to 200 or 250 per cent. rating at certain periods of the day. The way to obtain good combustion is to watch carefully the brick work of the boiler, and see that all leaks are kept down. See that baffles are in good order and that there is no short

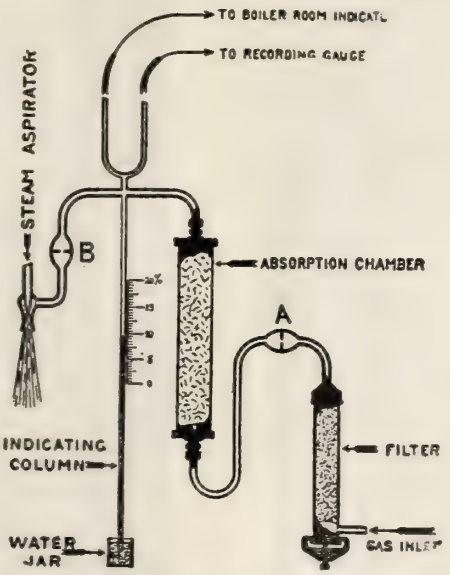


Diagram of CO2 Recorder and Indicator.

circuiting of gases between one pass and the next. Keep the fires the same thickness over the whole of the grate area, and avoid thin spots and holes. Regulate the damper when working with natural draught so that the air is sufficient but no more. Watch the flue gas temperatures, if you have the instruments to do so, and watch the CO_2 readings, and compare the two. If you have not got the instruments get the manager or owner to give you an hour of his time some day and explain carefully to him just what excess air or not enough air means to him in dollars and cents.

DETERMINATION OF HEATING VALUE OF COAL

The most accurate method of determining the total heating value of a coal sample is by combustion in a bomb calorimeter, states the Bureau of Mines in Bulletin 193, just issued. The instrument should be carefully standardized by burning substances of known calorific value, such as the standard samples of cane sugar, napthalene, and benzoic acid, that are now being furnished by the Bureau of Standards. The standardization should be conducted under exactly the same conditions and with the same thermometer that is used in the tests. The use of calibrated thermometers is essential. In carefully conducted calorimetric work the probable error should not exceed 0.2 per cent., which corresponds to about 30 B. t. u. in a high-grade coal. This degree of accuracy is higher than can be obtained in the usual methods of sampling, the error introduced by which oftentimes increases the total error to 100 B. t. u.

DETERMINATION OF GAS IN BOILER FEED WATER

Work is being done at Pittsburgh Pa., by the United States Bureau of Mines, on a portable method for determining the dissolved gases in boiler feed water, especially hydrogen. Some boiler feed waters have been found to contain more than 30 per cent. hydrogen.

EXPLOSIBILITY OF POWDERED COAL

The causes and effects of fires or explosions, due to the ignition of coal dust from the use of pulverized coal as a fuel, at a number of industrial plants, have been investigated by L. D. Tracy, coal mining engineer, of the Bureau of Mines. A bulletin on the general subject of coal dust explosion hazards in industrial plants will be issued by the Bureau at a later date.

BOOKLETS

Bearings and Bearing Metals is the title of an engineering bulletin just issued by the A. W. Cadman Manufacturing Co., Pittsburg, Pa. It contains a brief history of the development of bearing metals, covering the different types of metals and alloys used, the requirements of a bearing material, the friction in bearings and the proper lubrication of the same. This firm has likewise just issued a bulletin on Cadman metals which comprises a digest of sixty years' pioneer work in the development of fine bearing metals. Both of these booklets are short treatises of semi-technical information on bearing metals and their uses.

Application of Electric Steam Generators

The Development of the Water Resistance Type, Means of Regulating Supply of Water, and Methods Adopted to Safeguard the Apparatus, is Described in Detail

By P. S. GREGORY*

THE subject dealt with in this paper is the commercial application of electric energy for the production of steam by means of the water resistance type of electric steam generator.

The production of steam by means of electric energy is not a new process, and the water resistance type of electric steam generator has been in use in Europe for some fifteen years, though in the majority of installations in small sizes only, of 1,000 Kw. or less.

In general the cost of electric energy is such that it cannot be used commercially for the production of steam, but there are circumstances under which the conversion of electric energy into steam, even on a large scale, becomes economically feasible. The required conditions are a surplus amount of electric power, for which there is no other use at certain times, or a cheap supply of power. One or other of these conditions frequently exists in industrial plants. All manufacturers who purchase their power on a flat rate basis have at certain times in the day, or on certain days in the month, power available for which they have paid under their contract, but of which no use is made. The saving of coal which can be effected by the conversion of such surplus power into steam is a subject worthy of careful consideration. In the case of the existence of a cheap supply of power, the price which can be paid for this energy for the purpose of the production of steam is of course dependent upon the price of coal, and can readily be calculated.

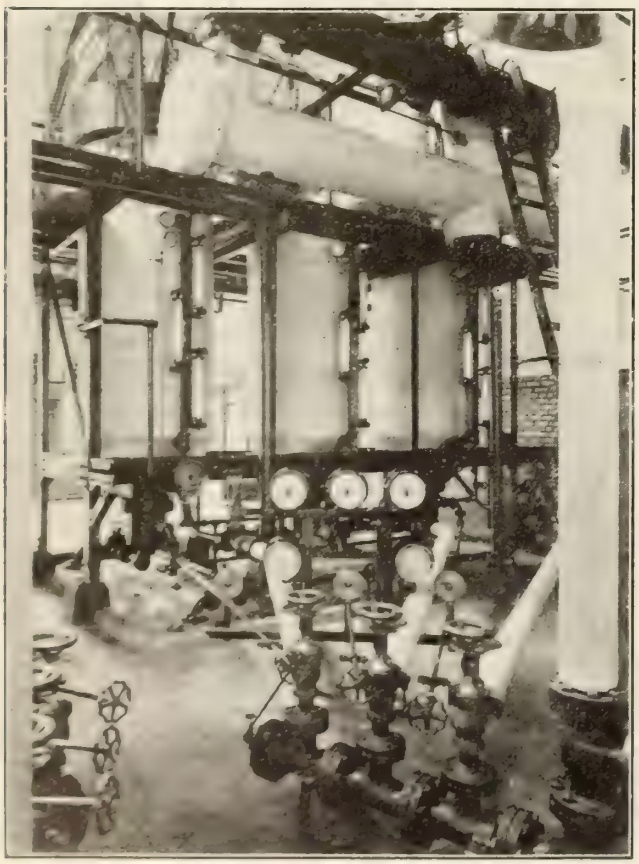
The fundamental relationship between electric energy and heat energy as pertaining to the production of steam may be stated as follows: One Kw. H. is equal to 3,412 British thermal units. In order to produce one pound of steam at a gauge pressure of 100 lb. per sq. inch, from feed water having an initial temperature of 150 deg. F., 1,070 B. t. u. are required. Therefore, if the conversion of electric energy into steam can be made at an efficiency of 97.5 per cent. one Kw. H. will produce 3.1 pounds of steam at the above conditions of temperature and pressure.

Under average conditions 1 pound of coal in a boiler will produce about 7.5 pounds of steam and therefore, the electric energy which is equivalent to one ton of coal is 15,000/3.1=4840 Kw. H. This is equivalent to approximately 200 Kw. for 24 hours, so that for each ton of coal per day to be replaced by electric energy, about 200 Kw. of electric steam generator capacity is necessary. On the basis of 4,840 Kw. H. being equivalent to one ton of coal, which is valued at say $8 under the boiler, the price which could be paid for electric energy would be 1.65 mils per Kw. H. If therefore, a supply of power is available at a price not greater than 165 mils per Kw. H. in a plant where coal costs $8 per ton or more, the production of steam by electric power is commercially feasible.

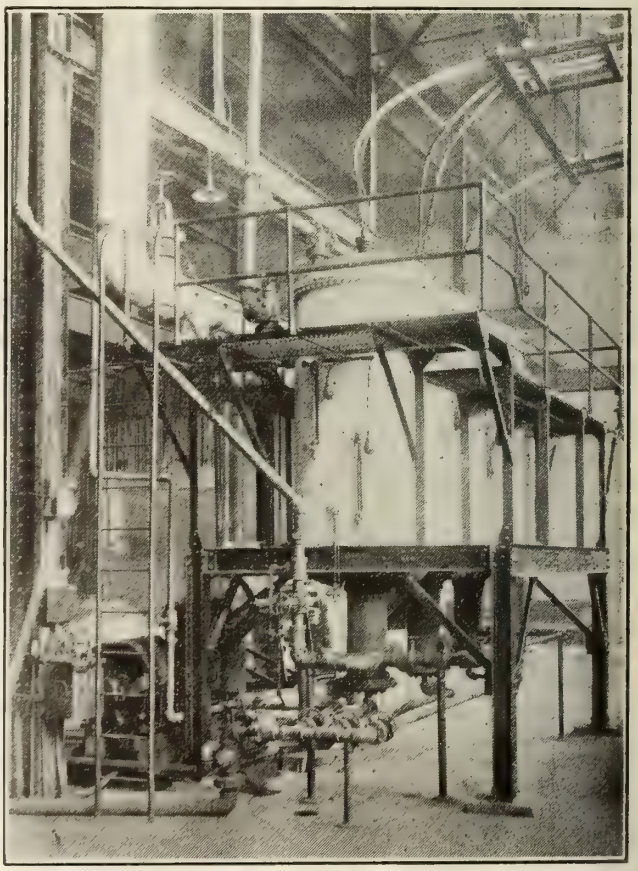
The water resistance electric steam

Paper read at meeting of American Electrochemical Society.

*The Shawinigan Water and Power Co.



An Electric Generator.



Another View of Generator.

generator consists essentially of a closed pressure vessel to which is connected a source of water supply, and from which water may be drawn off at the bottom and steam at the top. In this vessel electric energy is made to flow through the water from an electrode in the form of a plate, or tube, to the shell of the vessel, or to the metallic inner lining. Alternating current energy is used at a pressure varying from 110 up to 12,000 volts. The generators are constructed for the use of 3-phase power, either by employing three electrodes in one vessel, or by the use of three vessels with one electrode in each, in which case the outer shells are connected together in star. In this type of generator there is no heating surface, the generation of steam taking place throughout the water, and as a consequence no portion of the apparatus is at a higher temperature than the temperature of the steam. This is a most important feature from the viewpoint of safety and continuity of operation, as can be readily appreciated.

The chief advantages of the water resistance type of steam generator over the metallic resistance type are freedom from electrical and mechanical troubles, ease of regulation and cheapness. This type of generator has recently been further developed and made applicable to conditions on this continent by Mr. F. T. Kaelin, chief engineer of the Shawinigan Water and Power Co. Units of Mr. Kaelin's design, manufactured by the Dominion Engineering Works, Limited, Lachine, Que., and the Electric Furnace Construction Company, Philadelphia, Pa., are in operation up to 25,000 Kw. capacity. A full description of this type of generator is given in Mr. Kaelin's paper, read before the Montreal section of the Society of Chemical Industry, the Engineering Institute of Canada and the Canadian Institute of Mining and Metallurgy, on January 19, 1922. A low voltage type of water resistance generator was described at the fortieth general meeting of the American Electrochemical Society in October, 1921, by Messrs. Lidbury and Stamps.[3]

In the operation of this type of generator the load or electrical imput is dependent directly upon the area of electrode immersed in water, and inversely upon the resistance of the water. The variation of the water level or the area of immersion is affected by the operation of the valve in the feed water supply line. The resistance of water decreases with temperature, the relation being expressed by the formula[4]

$$R = \frac{C}{\sqrt{T^4}}$$

in which R = ohms per cubic inch, T is the temperature in °C, and C is a constant having a value of about 42,000 for raw river water, and about 87,000 for condensate containing 25 per cent. of make-up water.

The variation of the resistance of the water is effected by controlling the amount of water bled from the bottom of the generator. This water contains a comparatively high percentage of salts, and is therefore of a low resistance, so that an increase in the amount of water bled from the generator means an increase in the resistance of the remaining water and consequently a decrease in the load.

In actual operation it has been found that for ordinary fluctuations of load, such as are obtained in paper mills, a practical method of operation is to maintain a constant water level, and to vary the output of the generator by varying the resistance of the water by means of a bleeder valve.

There are in operation in Canada and in the United States at the present time installations of electric steam generators totalling about 150,000 Kw., which are for the most part installed in paper plants. One of these units is shown in the illustrations on page 28.

The accompanying diagrams illustrate the present development of the electric steam generator.

Fig. 1 shows a cross section of one of the three tanks of a 25,000 Kw., 6,600-volt unit. The electrode is supported at three points to give mechanical stiffness. The feed water is deflected around the sides of the tank by the funnel shaped casting shown in the bottom of the tank. It is found in operation that this method improves the cir-

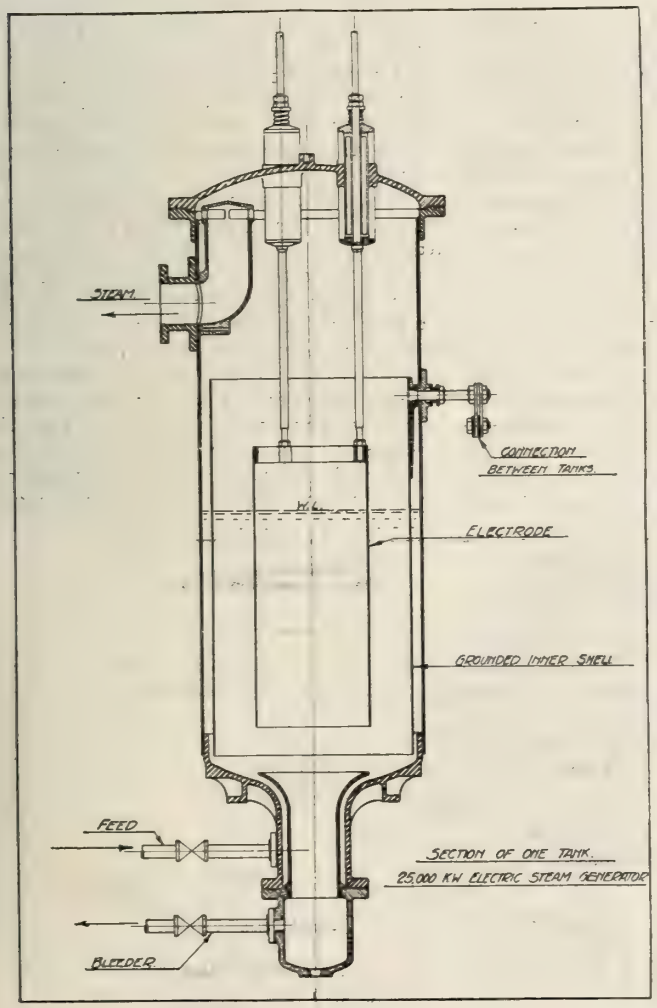


Fig. 1

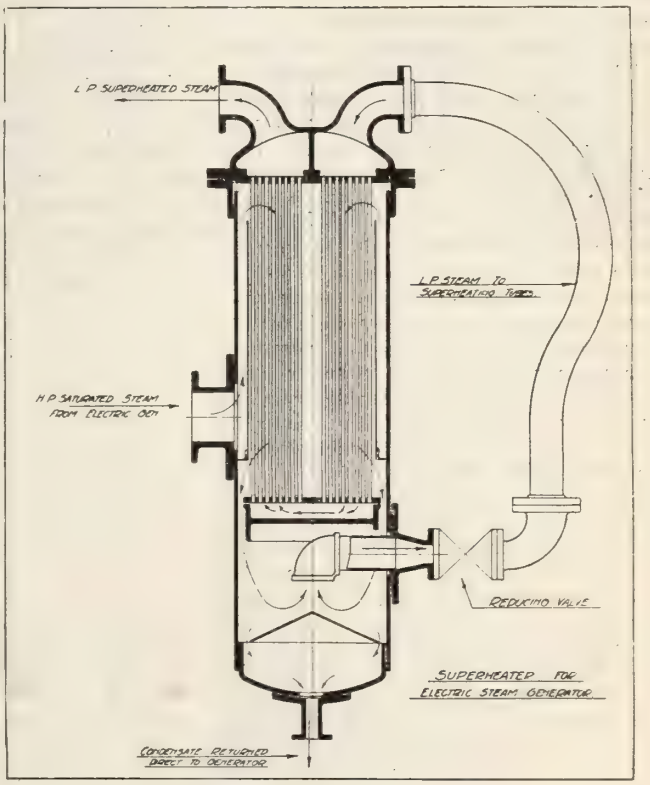

L.P. SUPERHEATED STEAM
L.P. STEAM TO SUPERHEATING TUBES
H.P. SATURATED STEAM FROM ELECTRIC GEN
REDUCING VALVE
SUPERHEATED FOR ELECTRIC STEAM GENERATOR
CONDENSATE RETURNED DIRECT TO GENERATOR

Fig. 2

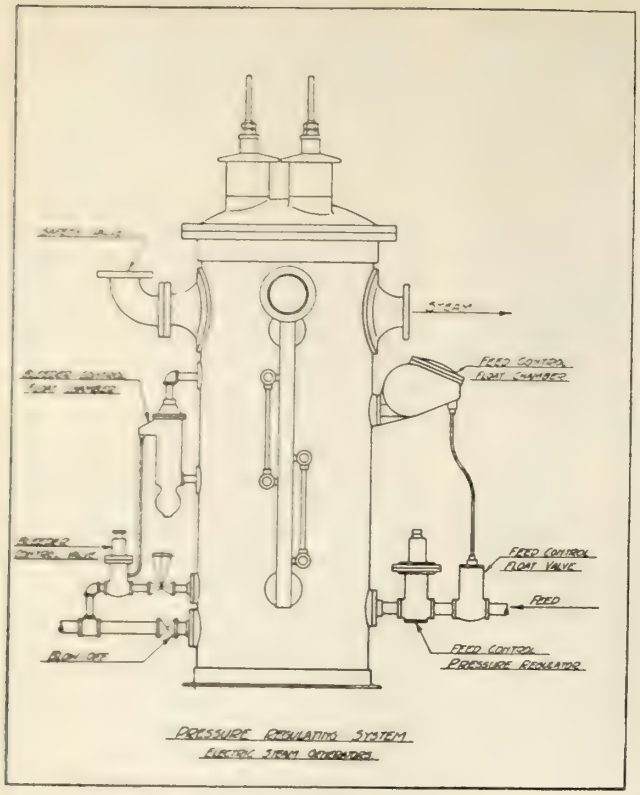


Fig. 3

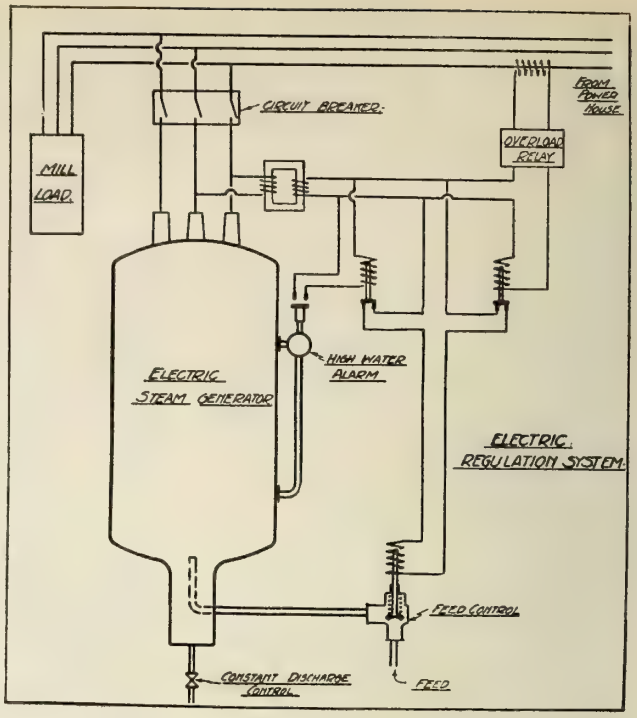


Fig. 5.

culation of water in the generator, and consequently lessens the tendency to prime. The inner shells are separated from the main walls of the vessel, so that even in the event of an electric arc being established between the electrodes and this inner shell, and damaging the inner shell, no weakening of the outer wall would occur.

Fig. 2 illustrates a super-heater by means of which about 50° of the superheat may be given to the steam. The principle of the super-heater is as follows: Steam is generated at a pressure of 300 lb. and is fed into the super-heater, flowing outside of the super-heater tubes. It is then passed through a reducing valve, which reduces it to 150 lb. pressure, and it is fed into the superheater again, passing inside the superheater tubes and thence to the main steam line. The steam at 150 lb. pressure inside the tubes, being at 366° F., absorbs heat from the 300 lb. pressure steam outside the tubes, which is at a temperature of 420° F., and passes to the main steam line in a super-heated condition. The condensate from the super-heater is drained back into the boiler feed. In a super-heater designed to super-heat 20,000 lb. of steam per hour at 150 lb. pressure from 2 per cent. moisture at 50° of super-heat the total heat to be transferred was 616,000 B. t.u. per hour. The mean temperature difference was 30° F, and the heat transferred per square foot of heating surface per degree temperature difference was 68.5 B.t.u. per hour. The electrical energy required at 90 per cent. efficiency was 180 Kw. The advantage of this type of super-heater is that the amount of super-heat produced is constant, and that there is no overheating of the super-heater in case only a small amount of steam is being drawn from the generator.

Fig. 3 illustrates a generator fitted with a pressure regulating system of control, so that the operation is automatic and no attendant is required. The principle of operation is as follows:

Under normal running conditions the pressure regulator valve on the feed line, which is actuated by the pressure in the generator, is open. If the steam consumption is reduced so that the steam supply exceeds the demand, the pressure will rise, and owing to the operation of the pressure regulator valve in the feed control, the amount of water fed to the generator will be reduced, and the water level in the generator will gradually sink. This may continue until a water level is reached at which the float valve opens in the bleeder line, allowing a quantity of impure high conductivity water to be drawn off from the bottom of the tank. This will have the effect of increasing the resistance of the remaining water as well as still further reducing the water level and therefore of cutting down the flow of current until the supply of steam becomes only equal to the demand, and the pressure regulator valve is operated by the reduction in pressure and opens allowing more water to flow into the generator, gradually raising the water level.

The float valve in the bleeder line is closed by the rising water level, which after one or more cycles of operation will finally attain a position such that, for the particular conductivity of the water in the generator, will produce a steam supply equal to the demand.

If, on the other hand, the demand for steam exceeds the supply, the pressure in the generator will drop, and the pressure regulator valve in the feed line will therefore be opened wide and allow more water to flow into the gen-

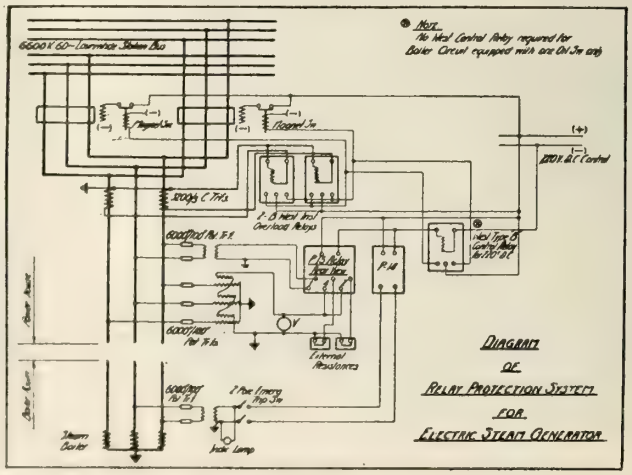


Fig. 4.

erator, raising the water level, and consequently increasing the steam supply until the pressure rises sufficiently to close slightly the pressure regulating valve, adjusting the inflow of water to the outflow of steam.

The possibility of the water level rising too high in the generator is avoided by the high level float valve in the feed line, which shuts off the water supply when the water level reaches the top of the electrodes.

A generator fitted with this system of automatic control, has been designed to supply low pressure steam for the heating of buildings. As the heating system is a closed system, the condensation being returned to the generator, it was not necessary to install a bleeder control valve on the heating generator.

The development of electric relay systems for the control of steam generators has kept apace with the other developments.

In the operation of the water resistance steam generator, the ordinary bugbear of low water has no terrors, but should an electric arc become established between one of the electrodes and the wall of the vessel, a dangerous condition would at once arise. This possible source of trouble has been avoided in two ways—by the installation of an inner protective shell separated from the outer wall by an inch or more, and by the development of a potential balance relay system by means of which should a ground occur on any one of the phases, the main circuit breaker is immediately opened. The opening of the circuit breaker does not depend upon the load on the generator, but only upon the potential balance, and the relay will function equally well from no load to full load, which is a very important consideration.

The complete electric relay system installed in connection with one of the larger units is illustrated in Fig. 4. The relays consist of the ordinary overload relays, the potential balance ground protection relays and an emergency hand-operated relay trip.

In order to make possible the application of the electric steam generator under conditions where a fixed amount of power is purchased, which is not all utilized in manufacturing operations, a relay system has been developed which will govern a total amount of power taken by the consumer, and will insure that all power not otherwise required will be utilized in the electric generator. The relay system is illustrated in Fig. 5.

The principle of operation consists in cutting in or out the feed water supply to the generator by means of the overload relays, which are operated by the total power consumed. The relays are so arranged that once the feed water is cut out it will not be cut in again until the total demand has been reduced some 10 per cent. below the contract amount. The shape of load curve obtained with a generator controlled by this type of relay system is therefore saw-toothed, and the relays can be so designed that the amount of available energy which is unused is less than 5 per cent. of the total energy purchased.

In conclusion it must be pointed out that the water resistance type of electric steam generator has now been developed to such a point that there is on the market today an apparatus suitable for the conversion of surplus electric energy into steam under almost any given conditions. Furthermore, in cases where power is cheap, or where fuel is expensive, or in special industrial processes, the electric steam generator can economically replace the coal-fired boiler.

3Trans. Am. Electrochem. Soc. 1921, 40, 467.
4The Generation of Steam by Electricity. March 1922.

NATIONAL ASSOCIATION OF PRACTICAL REFRIGERATING ENGINEERS

The thirteenth annual convention and exhibition of the National Association of Practical Refrigerating Engineers is to be held at the Planters Hotel, St. Louis, Missouri, this coming November 1st, 2nd, 3rd and 4th.

The Association expects a registration of at least five hundred members of its various subordinate chapters located in all parts of the United States, so this presents an inducement and the opportunity for every refrigeration and ice-making plant owner to have his manager, engineer or someone else connected with the operation of his large or small plant, come in contact with others similarly occupied and interested.

In this way much can be learned of what is going on in other cities and knowledge obtained of new things and new methods that should be useful and valuable to employees and employers.

Through coming in contact with others, the knowledge of their experiences would be taken up, the circle of their acquaintances extended and friendships formed that would be enjoyable and of benefit.

It should be kept firmly in mind that the first object of the Association is to further the education and worth of its members in the art and practices of refrigeration engineering.

The principal means toward this end is the holding of sessions for the reading and discussion of appropriate papers and for craft fellowship.

Each member subscribes to the belief of community of interests of employer and employee, and the Association is never used for the furtherance of strikes or anything that will interfere with perfectly harmonious co-operation between them.

The Association at no time takes partisan issue with rival interests in the refrigeration and ice-making businesses, nor is it used for political or religious purposes.

Its meetings are devoted to the business of the Association, and at all times preference is given to topics relating to the instruction and education of its members.

COMBUSTIBILITY OF COKE

Further work on the combustibility of coke and relative re-activity with carbon dioxide is being conducted by the Southern experiment station of the United States Bureau of Mines, Birmingham-Tuscaloosa, Alabama, in co-operation with the Pittsburgh, Pa., station of the bureau. Two variable properties of coke, namely, its combustibility and rate of oxidation or "solution" in carbon dioxide, are believed to play an important part in its performance in the blast furnace. It has been stated that the ideal coke should come down to the tuyere zone without oxidation by the carbon dioxide in the stack gases (Gruner's idea working) and should there burn rapidly carbon monoxide. Laboratory scale tests for determining relative combustibility of cokes and their reactivity with carbon dioxide have been developed and a number of by-product and beehive cokes tested. The relation between these values and the physical properties of the coke has been studied. A comparison of laboratory scale test results and results of actual furnace practice is being made.

Keith Electric Refrigerator Co., Toronto, have been incorporated to manufacture refrigerators and refrigerating plants and appliances.

The annual meeting of the American Electro-Chemical Society was held in Montreal during the past week. Many interesting papers in connection with electric heating were read and discussed.

A chain drive installation, said to be the largest in any grain elevator in the world, was recently placed in the Northern Central Elevator at Baltimore. This drive was one of 7,000 h.p. and made by the Morse Chain Co. Similar drives of approximately the same h.p. are located in other elevators in Canada and the United States.

Regina, Sask.—Construction of two giant oil tanks is planned by Imperial Oil Co. on the 40 acre tract of land adjoining the Regina plant, which was recently purchased by that company. These containers will be the largest of their kind in Canada, if not on the continent. Each will have a capacity of over 90,000 barrels of oil.

By the use of electric steam generators in the Laurentide Paper Mills and the Belgo-Canadian Pulp and Paper Co.'s plant in the St. Maurice Valley, four hundred tons of coal are saved daily. Unlike other systems of generating steam, the off-peak hours can be utilized for this purpose.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

TORONTO, OCTOBER 5, 1922

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High Pressure Steam

IN THIS issue there is a description of a new design of boiler, which will work at the high pressure of 400 lbs. per square inch. In addition to this high pressure the steam will be superheated to a temperature of 700 degrees Fahrenheit.

It speaks very highly for the development of the materials with which the engineer can work, that these high pressures and temperatures have become possible in a plant such as central station of a public utility. It requires very special qualities in the metal of valves and valve seats to sustain the action of such high temperature steam without deformation and excoriation, and a few years ago such pressures were beyond the realms of possibility. We remember some twenty years ago, a number of large cargo vessels were built, having quadruple expansion with five cylinders, and a working pressure of 250 lbs. per square inch, but the troubles encountered with leaky valves and burnt out packing etc., discouraged any further development at that time. It was the practice in the British navy in high powered vessels to carry 250 to 300 lbs. per square inch at the boiler, but this was reduced to 180 or 200 lbs. at the stop valve of the high pressure cylinder.

The advent of the turbine has, of course, given the incentive and made the use of high pressure and high temperature steam a practical possibility. The greater the range of temperature between the entering steam and the exhaust the greater the efficiency, and as the final temperature is definitely limited, it is by increasing the initial heat that economies may be effected. Hence the 400 lbs. pressure and a temperature of 700 degrees.

* * * *

Fascination in Engineering

WE DOUBT if there is any other profession or calling which offers its devotees more in the way of interest than engineering in any of its many branches. It would seem as though there is scarcely a week passes, but something new is developed, or something old is vastly improved. It is but a short while ago that we knew in an academical sort of way, that electricity was being used on the Continent of Europe to generate steam. Then, almost before we had time to consider the possibilities, we find that it is in actual use right in our own country. The actual application of 400 lbs. per square inch in a central station has come about without any flourish of trumpets, but in a perfectly normal way of progress. Then just as we have got into the habit of thinking that the day of the steam reciprocating engine in large sizes has passed, we get the news of an engine of this type being built of no less than 25,000 horse power, for the hardest possible service that an engine can be put to. When driving a rolling mill, as this engine will be doing, the load jumps from a minimum to a maximum, and reverses its direction many times a minute. When one thinks of the enormous weights of the reciprocating masses in an engine of this size, it induces a wholesome respect for the engineer who designs such a machine.

Outside of the realm of steam, but still in the field of power, the internal combustion engine has steadily forged ahead, overcoming the numerous initial difficulties with which it was beset, until it occupies a well recognized place, in the available catalogue of power producers. An internal combustion engine has been produced which utilises the principles of compound expansion of the gases in two cylinders, just as the compound steam engine does. All over the world research engineers are studying and experimenting to evolve the commercially possible gas turbine, as yet without success, but with enough partial success to encourage them to continue in their endeavors.

To the man who takes the right sort of interest in his profession, and is anxious to keep abreast of modern developments, there can be but little chance of dullness. There is but little excuse in these days of cheap publications for any one, however limited their time and opportunities, for falling into a rut, the sides of which hide the rest of the world from the unfortunate occupant.

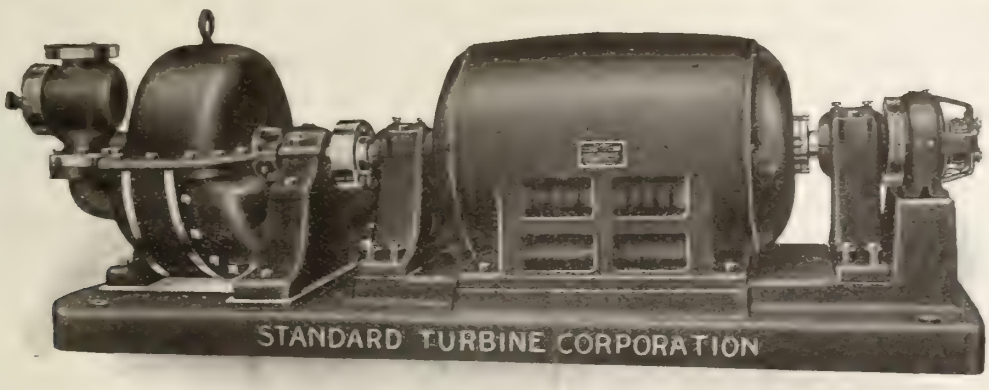
* * * *

Electric Steam Generating

SOME MONTHS ago we published an account of an electric steam generator, designed to make use of surplus power which would otherwise have been lost to the consumer. We are enabled again to publish further developments of this interesting apparatus, of a more detailed nature. To the engineer who has lived all his life in the shadow of danger from low water, there cannot help but be a certain appeal in a boiler that, as the water vanishes, simply gives up generating. No water, no heat is the rule in this apparatus. There is a danger, however, of a ground occurring between the shell of the boiler and the electrode when there is little or no water in the vessel, but this danger has been discounted by the introduction of a potential balance, which is independent of the load, but functions the moment any unbalancing of the phase potential such as would be caused by a ground occurs. The boiler has been made so as to automatically regulate its own pressure, by cutting the feed water in and out as the pressure rises or falls. This is made possible, of course, by the fact that the water itself supplies the resistance to the current, and therefore the amount of current flowing will depend on the amount of water present.

It has long been the dream of many hydro-electric enthusiasts to perform all power and heat development by means of electric power generated from water power. There are a good many obstacles in the way of those dreams being realized just yet, but the electric steam generator does certainly open a way, if fully utilized, of providing a steady twenty-four hour load, where there are at present short periods of high peaks, and long periods of little or no load.

Progress in New Equipment



Outside View of Turbo Generator.

A NEW MAKE OF STEAM TURBINES

The Standard Turbine Corporation of Wellsville, New York, are placing on the market a series of steam turbines in capacities up to 600 h.p. The following information has been given us by Mr. Willis D. Bishop, Montreal, who represents this company in Canada.

The various frames of turbines include one small size suitable for horse powers of 1-20th up to 10 h.p., for generator, pump and blower drive. The larger machines are built in single and multi-stage sizes for condensing and non-condensing service and are suitable for connecting to A.C. and D.C. generators, pumps, belt drives, fans and other types of mechanical applications.

The cut in Fig. 1 shows a small Standard turbine connected to a generator. This type of unit is built in capacities from 400 watts up to 15 kw. They are made for **use in hotels and apartment houses** to furnish light and power; the exhaust steam from the unit being used for heating and cooking purposes. In addition to its many other advantages this type of unit lends itself excellently to these purposes from the standpoint of cost of power even in cases where electrical power from a central station is available at low cost, for where it is possible to utilize the exhaust steam for the above mentioned purposes, the power becomes a by-product and the heat energy, not absorbed in the turbine, is available in the exhaust steam. The turbnie unit has fundamental advantages compared with engine driven machines in its quietness of operation, absence of vibration, and constant voltage irrespective of steam and load conditions, and also in the fact that it requires a minimum attention.

These machines are also used to good advantage for similar purposes in **laundries, small factories and mills.** The low steam consumption renders them entirely suitable even where the exhaust steam cannot be used. They are also used extensively in the **oil fields** around oil drilling and pumping rigs where they have proven advantageous because of their absolute safety and on account of convenience in handling due to their small size, light weight, and ease of installation and operation. The unit being completely enclosed having all moving parts in the interior thus being entirely weather-proof, it may be set up in any location and since two members of the machine are both together and on a common base plate, no special foundation is necessary for the machine, but a floor or wooden shelf is all that is required for its support.

These units may also be used to advantage in connection with **electric hoists** for generating current and electro magnets. They are then built in larger capacities of 7½ to 10 kw.

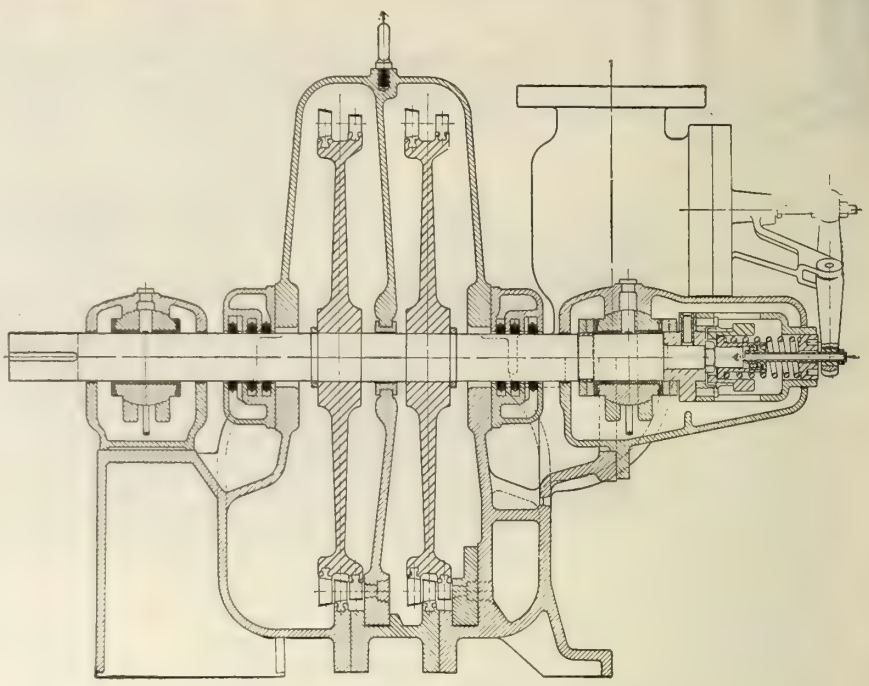
The turbines are all made for non-condensing service and will operate successfully under steam pressures down to 50 lb. per square inch. The casing of the turbine is made of close grain cast iron, tested hydraulically to twice the pressure which it will be subjected to in operation. The turbine rotor consists of a carbon steel wheel, bronze blades accurately milled to fit dove-tail in the wheel; the wheel being mounted on the shaft and the whole rotor carefully balanced. The nozzles are made of bronze to successfully withstand corrosive and erosive action as might otherwise take place due to the moisture in the steam generally found with boilers of the type used in oil fields, on electric cranes, etc. The governor is of the centrifugal type, all parts being carefully machined and balanced and of special patented design, having extreme simplicity and frictionless operation as its object. The governor has a total of five parts, mounted and attached securely to the rotor. The steam valve is of the balanced type and made of phosphor bronze so as to have the highest resistance against wire drawing action of the steam. The same turbines used for the above mentioned generator sets may also be used for other drives. They have in many instances been furnished for centrifugal pump drives, in refineries, milk plants, etc., and are also suitable for connection for fans and blowers, and centrifugals of various kinds. The sectional cut, Figure 2, illustrates a larger size of Standard steam turbine. These machines are built in single and multi-stage types for condensing and non-condensing service up to capacities of 600 h.p. The casing throughout is made of close grain cast iron or cast steel tested hydraulicly to a pressure twice that of the maximum working pressure. The steam end has bolted to it the nozzle ring in which are accurately reamed the first stage nozzles. The intermediate carries nearest the steam end the first row of stationary buckets and nearest the exhaust end it has inserted into it the diaphragm in which are reamed, or cast, the second stage nozzles. The exhaust end carries the second stationary row of buckets. On the horizontal joint of the lower half of the steam end there is a

flange for attachment of the turbine steam chest. This joint and the nozzle ring face are the only high pressure steam joints in the entire machine. The stem ring is stopped off at the horizontal joint so that there is no opening at this point through which leakage might otherwise occur to the interior of the turbine. The main bearings are either made of bronze or cast iron babbitt lined. The exhaust end bearing is supported on a pillow block resting upon a pedestal integral with the lower half of exhaust end thus having an especially rigid attachment to the base plate, thereby eliminating possibility for vibration and misalignment at the coupling end of the turbine which is of the greatest importance. The steam end bearing is directly under the bearing and the over-hang hence being short and rigid as compared with construction common on other turbines. The bearings proper are made in halves absolutely interchangeable and removable by the taking off of the caps. A thrust bearing is provided on the steam end, being made up by four collars attached to the shaft on threaded sleeves set into accurately machined grooves. These thrust collars are machined by special process whereby their faces will be perpendicular to the axis of the shaft. These thrust collars will permit of adjustment to the rotor in axial direction and will also permit of adjustment for wear on the bearing. Inherently the turbines have no end thrust but there are causes such as clogging up of blades with foreign material, etc., which may cause end thrust.

Shaft Packing

Leakage of steam at the casing ends is prevented by carbon rings set into packing cases. The packing rings have a liberal clearance on the sides so as not to become stuck between the partition walls, due to possible impurities in the steam and have a large clearance on their outside diameter to allow free movement in that direction and prevent possibility of their riding on the case. They however, have a small clearance by one to two thousandths of an inch on the shaft to prevent steam leakage at that point. The rings themselves are made in three segments, held together by a coil spring and prevented from rotating by means of stops set into milled slots in the cases.

The rotor consists of heavy steel shaft, upon which are mounted the bucket wheels, thrust collars, coupling and governor. The weight of the rotor and the shaft diameter are such that no critical speed will come any nearer an operating speed than 30 per cent. Disks which carry the rotating buckets are shrunk on to the shaft with a shrink fit heavy enough to overcome the maximum tensional stretch at the bore, and still have a liberal margin to insure good holding power on the shaft. The disks are made in one piece, each carrying two rows of buckets. This construction permits of a long fit on the shaft and also reduces the disk stresses at the hub materially. The wheels are made of high grade carbon steel thoroughly homogeneous and after machining are carefully balanced on specially prepared arbors. The wheels are keyed to the shaft securely. The revolving buckets are milled from bronze, cupro nickel, or monel metal, depending upon the steam conditions and are set into dove-tailed turned grooves in the wheel, spaced accurately relative to each other by means of accurately machined spacer pieces. Steam spillage on the outside is prevented by bands set into milled slots in the sides of the buckets and braced securely to these buckets. The construction of these shroud bands is such that they are prevented from being thrown off or damaged through the holding power of the buckets themselves. The bracing is not depended upon to prevent this. The bracing merely hinders the rings from sliding out sideways.



Sectional View of Turbine.

The Governor

The governor is of the centrifugal type and consists of two weights, fulcrumed on knife edges resting in hardened and ground knife edge seats in a governor housing attached by means of a housing hub to the shaft, the movement of the weights being resisted by a compression spring against a shaft sleeve, the outer end of the compression spring resting against an adjustable nut screwed into the housing. Adjustment of the speed is secured by the screwing down on the spring by means of this nut. The governor housing is made of best quality bronze, the weights are made of carbon steel and the sliding sleeve on the shaft is also made of steel. The governor housing hub, above mentioned, has a long fit on the turbine shaft to secure the most rigid and true attachment to the same and the joint between this hub and the housing is turned after the assembly of the hub on the shaft. This insures true running of the governor in all cases. Possibility of vibration in the outer end of the governor has been entirely forestalled in that the governor spindle has been made stationary and extending into the end of the shaft where the rotary motion is transferred into a lineal motion for the movement of the governor valve. The pivot block proper hence is directly at the end of the shaft and in the interior of the governor. This arrangement has another advantage not possessed to any degree by another type. It permits lubrication of the sliding shaft sleeve from the outside through the hollow governor spindle, which lubrication eliminates the wear on governor parts. Over travel of the weights is positively prevented by a heavy pin at the end of the shaft limiting the movement of the shaft sleeve. The governor housing is attached to the hub by means of four heavy bolts, two on each side of the knife edges. The governor is therefore entirely independent of the turbine shaft and may be removed from same without dismantling, and also can be tested independent of turbine shaft and attached to the same without disturbing the setting. The governor is quick in action in response to load or pressure changes, is stable, and requires a minimum attention.

An emergency governor is always provided which will automatically shut down the turbine should the speed exceed the normal speed by pre-determined amount, usually this amount is 10 per cent. The emergency governor consists of a plunger inserted into the governor hub, resisted by a spring of such characteristics that its initial com-

(Continued on page 36)

The Operators' Point of View

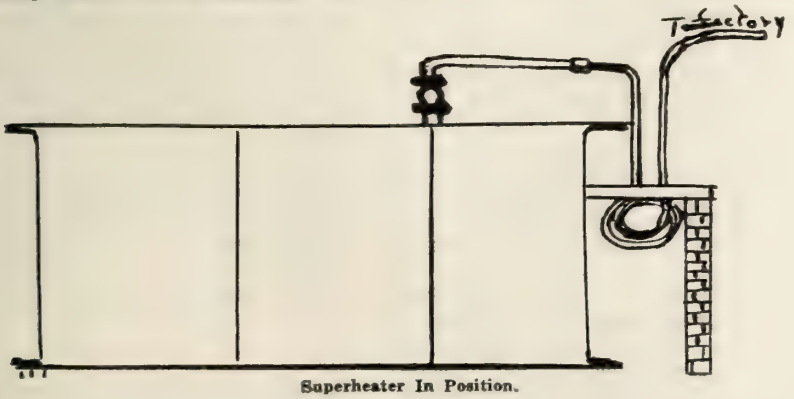
MAKING A SUPERHEATER

By A. E. Pritchard

In a candy factory where I used to work they had steam heated jacket copper kettles of various sizes for the purpose of cooking in the process of candy making. These kettles were

Coil Superheater.

bought second hand and with no stated pressure stamped on them to carry with safety, nor could the maker's name be found regarding them. However, we carried 125 lb. gauge on the boiler for some time when one day one kettle developed a large crack around near the bottom and steam leaked. Of course the operator closed the steam valve and fortunately there was no mishap. The boiler inspector was called to investigate the matter, and he said that we would have to reduce the pressure to 70 lbs., so we did. However, the candy makers found that this pressure was too slow, being not hot enough: 70 lbs. = 316° F.; 125 lbs. = 352.8° F., a difference of 32°, according to the steam tables for saturated steam. So to overcome the difficulty I installed a small superheater. The boiler was a 50 h.p. return tubular and the superheater consisted of a 1½-inch heavy steel pipe coiled into five coils; the steam after passing through the coil was superheated 60°. The change was very satisfactory and is still in operation over 5 years. The fuel was natural gas.



Superheater In Position.

KEEPING THE CO^2 RECORDER IN TRIM

By W. F. Schaphorst

Speak about a CO^2 recorder to the average steam engine operator and he is liable to take on a confused air because he doesn't know what CO^2 means, and feels that he is wading in beyond his depth in attempting to converse on such a subject. CO^2 belongs in the realm of chemistry and not in engineering according to the notions of the average engine runner.

However, there is nothing complex about operating a CO^2 testing machine. The engineer doesn't necessarily have to know anything about chemistry, even though combustion is a chemical process. He needn't even know what the chemical symbol CO^2 means. Continuous records are now made by a reliable machine that works automatically as long as it is in working trim. To keep in order is not a problem of chemistry, but one of mechanics, or perhaps some engineers would prefer to call it "engineering," in which case the engineer will fit into the job very well. Many engineers—thousands of them perhaps—are daily attending to their CO^2 machines and recorders and are doing their work perfectly. Yet they don't know any more about chemistry than any other average man who has never dabbled in chemistry.

If you have a CO^2 recorder in your plant you will find it a good plan to instruct several men in its care. There is no reason why the chief engineer alone should be able to care for it. In fact, it is better for the chief to assign the duty of keeping the analyzing machine a-going to a subordinate and make it his regular job. Should the chief attend to all such details himself he will certainly overlook them on days when he considers other work more important.

THAWING OUT PIPES

By J. Ellethorne

Winter will soon be with us and the problem of thawing frozen water pipes, many of them in locations difficult to get at, will have to be solved by the men in the power plant. Using the gasoline blow torch has its good and bad points, it is clean but the intense heat from the flame is liable to cause split pipes, due to rapid contraction or expansion. There is also the danger of firing the building when using it around dry and dusty places. Pouring hot water on a long length of pipe is a slow and unsatisfactory method for thawing a frozen water pipe. It usually gets the workman wet besides causing a nasty wet mess around before the job is finished. Whether using the flame or hot water method on a long line of pipe where the temperature is still low, some attempt should be made to secure an opening in the pipe so that the water from the ice will drain away as it is melted, otherwise it is liable to freeze up again before the entire length is thawed. The frozen pipe may be underground or in other locations where it is impossible to use either of the methods mentioned. Special electrical and steam apparatus is manufactured for thawing such pipes, but the average engineer can use a simple outfit of his own that will give very good service. A coil of ⅛ inch block tin pipe with an attachment on one end allowing it to be connected to a steam or hot water supply pipe is used. The frozen pipe is disconnected and the other end of the tin pipe is entered and the steam or hot water turned on. As the ice is melted the tin pipe is pushed in until all the ice is melted. This method is very successful in thawing service pipes as the line seldom contains elbows or bends. Of course a pipe so thawed will freeze again

in a short time unless the water in the pipe is kept moving, because the earth around the pipe is still frozen. If there are elbows in the line it may be necessary to dig down at the point where the elbow is located, this point can be determined by noting the length of tin pipe inserted. When high pressure steam of 50 pounds or more is available the elbow can be reached by attaching a steam hose to a five or six foot length of ¾ inch iron pipe with a handle attached so that it can be held in an upright position. This tool is used to thaw a hole in the earth. It will soon force a hole down to the elbow. It will also thaw the ground around the elbow, hence it will be unlikely to freeze again. Of course a valve must be used on the pipe so that the men using it can regulate the amount of steam. If there is no hurry to get at the frozen pipe underground and the exact location is known, it is possible to get it thawed by excavating a hole a couple of feet deep and filling it with unslacked lime, then pour some water on the lime and cover it over with boards and old rags or other cloth. The heat generated in the lime will thaw out the earth for several feet in depth in a few hours. If no tin pipe is available and the frozen pipe is fairly straight, small rubber tubing can be used but the hot water or steam may make it so soft that it can not be pushed ahead for long distances. The tin pipe is hard but pliable and can be pushed past long bends or double offsets without difficulty, often past 45 degree elbows but not through 90 degree ones.

BOILER INSPECTOR'S QUALIFICATIONS

By Jimmy Hamilton

There is a question that should be of interest to engineers, in the following. Have all Government and Insurance Company stationary steamboiler inspectors got engineer's certificates in Ontario? Should it not be compulsory as a matter of public safety that only men holding First Class papers be allowed to act in this capacity? The modern inspector is expected to certify, so long or so far as obtainable knowledge and practical experience permits, not only the safety of the boiler but also the condition of the safety and other valves, the condition and safety of the piping and other possibly dangerous equipment in the boiler room. His opinion and advice is often asked and acted upon in reference to engine room equipment, etc., so it appears to the onlooker that if a man in charge of a 600 B. H. P. plant is compelled to pass an examination for 1st class papers the man who certifies as to the public safety of the plant should also hold the high class papers. As a matter of fact, so far as I know, it is not compulsory for such an inspector to hold papers at all. Perhaps some such inspectors hold certificates for which they never passed a personal examination or perhaps only second or third class ones, nevertheless they give an O. K. certificate as to the safety of such large plants. Personally I believe a mistake was made in not having such an important item as part of the stationary engineers act. The ordinary man holding second or third class papers can do the ordinary inspecting, but the professional public inspectors should only be men holding First Class Papers.

HEAT LOSSES OF STORED COAL

Calorimeter tests to determine the losses in calories of coal heated in the air for various lengths of time are being made at the Pittsburgh, Pa., experiment station of the Bureau of Mines by J. F. Byrne. At 125° C. the following heat losses were obtained:

Time of heating	Per cent. loss
30 min.	.30
1 hour	.26
2 hours	.311
3 hours	1.01
20 hours	3.3
45 hours	5.7

Samples were heated for various periods of time ranging from ½ hour to 100 hours, and the b.t.u. run by the coal laboratory. The results show no regularly increasing loss in heating value as the time of heating increases. The coal samples show a change of weight on heating—at first a decrease in weight due to the loss of moisture. The decrease is generally less up to 24 hours, when there is an increase in weight of .64 per cent. After heating 100 hours at 125° C. there is an increase in weight of 1.35 per cent. and a loss in heating value of 3.02 per cent.

HIDDEN WEALTH IN COAL

Greater attention is being given today than ever before in the history of engineering to the subject of fuel economy. Scientist after scientist has pointed out that the world is wastefully consuming its coal resources; and on this and other grounds endeavors have been made to deal with coal more efficiently than by burning it under a boiler or converting it at a high temperature into gas with a hard coke and various tarry materials as by-products. Great hopes have been entertained of the process known as "low temperature carbonisation," which differs from the ordinary process in gas works by reason of the heating of the coal to a degree much below the usual standard. The object is to obtain not only a supply of gas but also a smokeless fuel which will burn brightly in the ordinary grate, and as many as possible of the various fuel oils and other products of value in one direction and another. The whole question, which is exceedingly complicated, has been investigated by a Fuel Research Board appointed by the British government. This Board, which has carried out experiments on a large scale, recently issued its report covering the work of the years 1920 and 1921. The problem is not yet solved, but the information which the Board has produced represents the highest point yet reached in the endeavor to find a sound commercial method of utilizing the manifold wealth hidden in our black diamonds.

ORIGIN OF NATURAL FUELS

In the course of the study of the origin and composition of coals, being made by Dr. Reinhardt Thiessen, associate chemist, at the Pittsburgh, Pa., experiment station of the Bureau of Mines, results have shown that the group o natural fuels that includes cannel coals, torbanite, certain kerosene shales, oil shales, and boghead coals can be divided into four classes according to origin. The origin of torbanite, coorongite, certain kerosene shales of Australia, the bogheads of Bathgate, Scotland, and other boghead coals has been established. The report of the investigation is being prepared.

NEW MAKE OF STEAM TURBINES

(Continued from page 34)

pression will hold the weight in place until tripping speed is reached at which point the rate of change in centrifugal force will exceed by a large amount the same rate of change in the compression force of the spring, the so-called scale of the spring being relatively low and the initial compression being fairly high. These characteristics will make the emergency trip pin come out suddenly and strike the trip lever a decided blow which will release the heavy relay spring closing a butterfly valve in the steam chest casing.

The governor valve is of the hollow poppett type carefully balanced to prevent undue forces on the governor mechanism due to static or dynamic pressure. The bronze seats are made integral with each other and with a bronze bushing set into the steam chest. This construction is superior to cast iron or steel bushings with set in seats as the expansion with this construction is the same as that of the valve. Thus the valve can be closed on both seats at the same time under all temperatures which is a condition difficult of fulfillment with any other construction. The fact that the seats may be removed is a decided advantage even though the materials used have the highest resistance against erosive action.

The trip valve is a butterfly valve entirely independent of the main valve which construction is to be preferred over having the main valve tripped by the emergency governor as no wire drawing can possibly erode the emergency governor valve to a point where it will not successfully shut off the valve when tripped. It is also to be preferred over a flapper valve which might have dirt and impurities lodged on the seat preventing the trip valve from closing off tight.

Babcock & Wilcox Chain Grate Stoker

For Natural Draft

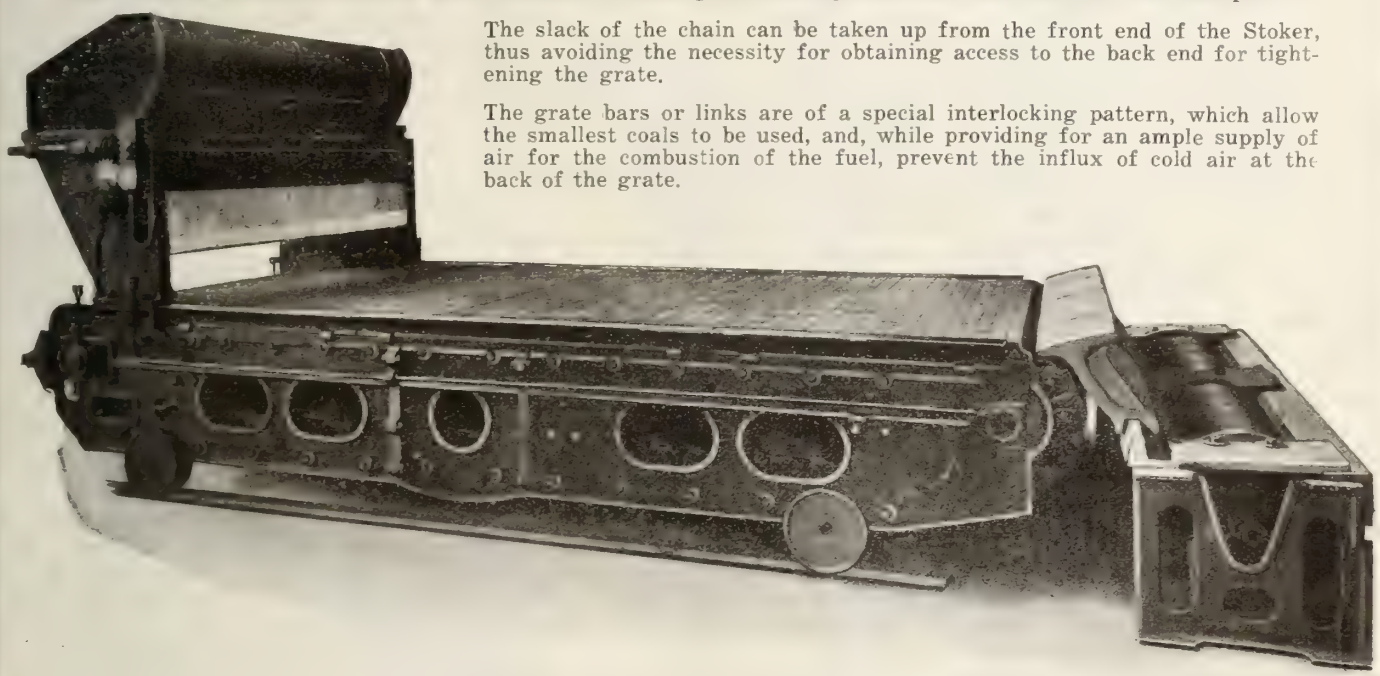
The grate consists of an endless chain of short interlocking cast-iron grate bars, linked together, running on angle irons and rollers and driven by a revolving shaft and sprocket wheels at the front end of the Stoker. The necessary power to drive the revolving drum is transmitted through a link chain and sprocket wheels from a shaft arranged either overhead or underground.

The starting or stopping of the Stoker, or the variation of speed, is effected through the B. & W. patent gear box, which can be driven at varying speeds. This box forms an oil bath in which the gear runs, and also contains an efficient clutch for putting the driving gear out of action should any unusual strain arise from an obstruction on the grate.

Any small repair, such as replacing a link, can be carried out with the Stoker in place under the boiler; but in case of need the whole Stoker can be brought out clear of the boiler, the frames being provided with wheels running on rails placed at the sides of the ashpit.

The slack of the chain can be taken up from the front end of the Stoker, thus avoiding the necessity for obtaining access to the back end for tightening the grate.

The grate bars or links are of a special interlocking pattern, which allow the smallest coals to be used, and, while providing for an ample supply of air for the combustion of the fuel, prevent the influx of cold air at the back of the grate.



The coal is fed over the whole width of the grate, and the depth of the fire is regulated by the adjustment of the vertically lifting fire door.

THE FEED OF THE COAL IS SLOW and the gas evolved from the fresh fuel as it drops on to the grate readily perfects its combustion by passing over the incandescent fuel further on.

The depth of the fire being regulated by a vertically lifting fire door, the Stoker CAN BE ADJUSTED IN A MOMENT to suit the class of fuel to be consumed and varying demands for steam, both by the depth of the fire and the speed of the grate.

The Stoker is easily manipulated and so simple that any fireman can understand it It is the only form of stoker in which the undue admission of air at the back of the grate is prevented and with it THE HIGHEST EFFICIENCY is obtained.

The Stoker ultimately proves itself the embodiment of economy because it is efficient and saves coal over any other method of firing and the cost of upkeep is low compared with any other type.

The first cost of some other makes may be less, but consideration must be given to whether they have the necessary metal in them to stand up under the work they are intended to do. By reducing the weight of metal the price can be lowered but only at the sacrifice of the durability, consequently the cost of repairs will be great. Due consideration should also be given to whether by any other method of firing the price of the Stoker can be recovered in the amount of coal saved in a given period.

Full information given on request.

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WINDING OF DYNAMO

Question:—We have a D. C. Shunt-Motor 125 volts, 50 amps speed, 500 r. p. m., which we use for incandescent lighting. Would you kindly let me know through the Power House the No. of turns per pole and what size of wire it would require to compound this motor to make it suitable for a dynamo.

Answer:—In answer to your query we are again faced with the usual difficulty encountered on all electro-magnetic problems, viz: lack of knowledge concerning the permeability of the metal forming the poles of the electro-magnets. As this quantity varies between such wide limits, it is quite impossible (in the absence of such information) to do more than make a rough approximation.

The shunt wound generator in question is required to be changed into a compound wound generator.

Let us therefore make a "picture" of the characteristics of this machine, and just what it is proposed to achieve in the alteration.

(a) Shunt wound generator has a characteristic of the form shown in Fig. 1. The shunt circuit always being closed, the generator builds up a strong "field" and develops a high E. M. F. on open circuit.

When the external circuit is closed, the armature current increases, causing an increased armature resistance drop and reducing the P. D. This results in weakening the exciting current, which naturally results in a lowering of the E. M. F.

This decrease is steadily increased with increasing load; however within normal working limits this decrease in E. M. F. is not excessive.

(b) Series wound generator has a characteristic of the form shown in Fig. II. The exciting current is the same as the load current, in other words whatever value of current is being supplied, that value is flowing round the poles of the generator.

Seeing that the intensity of the magnetic field is dependent upon the number of ampere-turns round the electro-magnetics, we have a condition wherein the turns are a fixed number, but the amperes increase with the external demand for more current. Such increase will therefore automatically increase the number of ampere-turns, this in turn will increase the magnetic field, which in turn will increase the E. M. F. of the generator.

Hence the reason for the "rising characteristic" of the curve shown in Fig. II.

We now have two conditions under consideration.

(a) Shunt winding, with a "falling characteristic."

(b) Series winding with a "rising characteristic."

It will therefore be obvious that if we combine the two systems of winding the field coils, the "falling characteristic" will tend to neutralize the "rising characteristic" and vice versa.

Such a system of winding is known as compound winding, this in turn may be divided into two types:

(a) Flat compound.

(b) Over compound.

Flat compound is when the series winding just has a sufficient number of ampere turns to maintain the voltage of the machine constant at all loads.

Over compound is when the series winding has a few more ampere turns than are necessary to maintain a constant voltage at all loads, and so increases the voltage of the machine corresponding to an increase in load.

These compound windings may be arranged on the pole pieces in different ways.

(a) Series windings outside the shunt windings.

(b) Shunt windings outside the series windings.

(c) Series windings at one end of pole pieces.

If magnetic circuit through iron work is good, the position of the coils of the various types of windings makes little difference.

It is important, however, that a size of wire should be chosen for the series windings that will offer the minimum resistance.

In the case of the machine mentioned in this query, we shall have no alternative but to wind the compound winding over the shunt winding (which is already fixed).

This particular machine is already developing a magnetic field of the proportions of which we have no knowledge. Therefore it is impossible for us to determine the necessary amount of series ampere-turns to make this machine into a compound one.

This may be experimentally determined as follows:

Connect up the machine to its load as usual, but insert an ammeter in the shunt winding circuit, so we can learn the value of the amperes in the field coils.

Count the number of turns of wire on one of the pole pieces then when we learn from the ammeter in the shunt winding, the number of amperes flowing round the winding, we shall know the number of ampere-turns in the shunt winding.

The shunt turns will be constant, but the amperes flowing through these turns will vary with the load on the machine. We can therefore easily determine the percentage increase in the number of ampere-turns from no load to full load.

Therefore take the reading on ammeter in shunt winding, when the machine is running at correct speed, and developing its normal voltage, but operating under no load.

Then gradually connect a load until the machine is operating at full load.

(Continued on page 40)

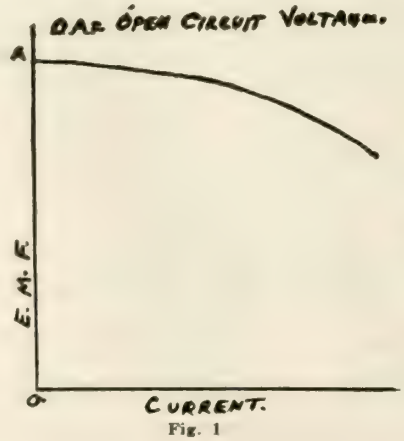


Fig. 1

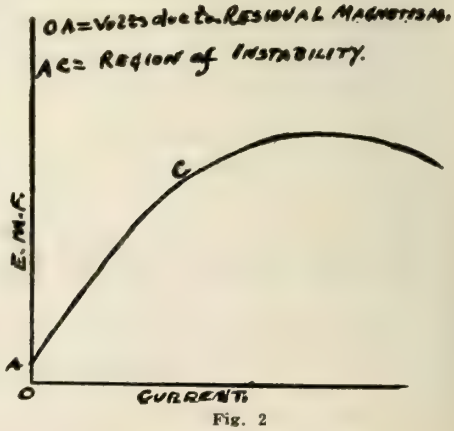


Fig. 2

HINTS TO BUYERS

Why Shovel Your Coal?

One man can unload and store a carload in 1½ hours with the Godfrey Conveyor at an average cost of from 5c to 7c per ton.

When you realize that this equipment costs no more than the price of a good truck, you will want to know more about it. Ask for catalog D.

Godfrey Conveyor Co.
Elkhart, Indiana, U. S. A.

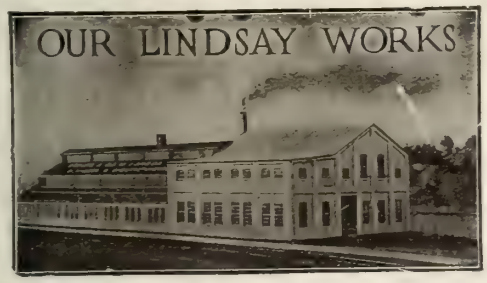
"Pop Off" Steam Carries Ashes Away

"Into the hole and away they go" describes ash removal with a Green Steam Jet System. At the Kewanee Boiler Co., they use "Pop off" waste steam to do the work.

Write to Dept. X for descriptive literature.

GREEN ENGINEERING COMPANY
175 Kennedy Avenue
EAST CHICAGO INDIANA

Water Turbines, Hydraulic Governors Centrifugal Pumps



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Lindsay, Ontario

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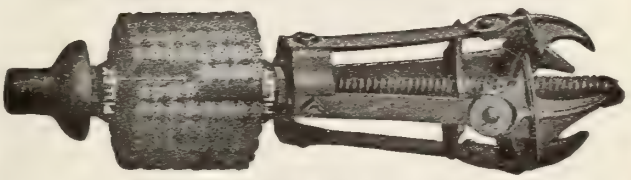

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Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
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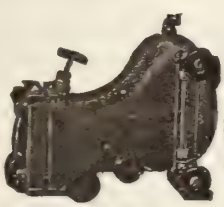

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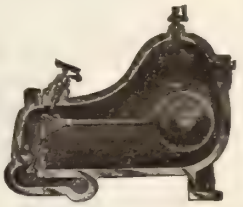
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

May We Send One for Trial?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.



Send for Catalogue

THE GARTH COMPANY
26 Craig Street - MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.

WINDING OF DYNAMO

(Continued from page 38)

whilst generating its normal voltage.

The number of series turns necessary to convert the above into a compound machine, will then be represented by the following equation:
(A. T. at full load — A. T. at no load). Divided by full load current.

As the resultant series turns will be expressed in ampere-turns, it will be necessary to divide this by the full load current of the machine which in this case is 50 amps. to obtain the number of turns of wire required.

The size of wire is determined by the amount of current it has to carry without overheating, with resultant excessive drop of volts.

It is very sound practice to take as a standard a current density of 1,000 amps. per sq. inch. If, therefore, 1,000 amps. needs 1 sq. inch, then 50 amps. being only one twentieth part of a thousand, will only need a similar proportion of a sq. in. This will be .05 sq. in.

It should be borne in mind that a compound wound machine is not suitable for charging storage batteries, therefore, if such a thing is contemplated, it would be necessary to insert a single pole switch in the series winding circuit, to permit of the series winding being "cut out" whenever the machine was being utilized for the charging of storage batteries.

There are many factors which enter into such a problem as this, such as air gap, dispersion factor, shape of edges of pole pieces, reluctance and permeability of the iron, etc.

Even in the designing room considerable leeway is permitted in the compounding of dynamos, the final corrections being made whilst on the test bed, in the old-fashioned method of "trial and error."

The instructions contained in this article will result in a reasonable degree of accuracy being achieved.

Finally it is usual to provide from 3 to 5 per cent. over compounding for lighting loads, and as much as 10 per cent. over compounding for traction loads. The additional ampere turns will be represented by an increase by similar percentages, as the amount of over compounding required.

—Geo. R. Archdeacon A. M. I. E. E.

COMPRESSED AIR FOR PULVERIZED FUEL

Some further details regarding the equipment to be used in handling the pulverized coal at the New Cahokia Station of the Union Electric Light & Power Company, St. Louis, Mo., has been announced.

Among these the method of weighing the fuel and conveying it from the pulverizers to the boilers is of unusual interest.

Below the floor level of the pulverizing room will be placed a series of five blowing tanks, which serve an equal number of twin pulverizing units. These blowing tanks will rest on platform scales, the dial of which will indicate to the operator in the pulverizing room the amount of fuel in the tank.

The fuel will feed into these tanks by gravity as desired from pulverizing fuel bins in the pulverizing room. Each charge will be automatically weighed and then elevated by compressed air to a height of about 75 feet through 4-inch pipes. By means of a simple system of switching valves and parallel distributing mains, cross connected, any blowing unit can discharge into any of the eight enclosed storage hoppers in the boiler house. These hoppers serve the four pairs of boilers of 1780 h.p. each, comprising the first group of boiler units to be installed.

The fuel requirements for the first group of units are estimated at 1,000 tons in 16 hours.

The accompanying drawing shows the general arrangement of blowing tanks with relation to the boilers. This equipment was selected on account of its cleanliness and freedom from mechanical complications which would be liable to interrupt service. Contract has been awarded Quigley Fuel Systems, Inc., New York.

40 YEARS OF GROWTH IN ELECTRICITY

Things that have been happening recently remind us of the newness of the environment we live and work in. The death of Alexander Graham Bell brought to mind the fact that the telephone—the little instrument that jingles on the desk all day—was invented more than a generation ago. Then came a further reminder—the 40th anniversary of the establishment by Thomas A. Edison of the first electrical central station in the world.

Astounding changes have taken place in the past 40 years. A man of 40 has passed through only the preliminary stages of his life, and is just about to enter its most fruitful period; yet the electric light, the generator, the motor and most of the other commonplace industrial devices of to-day are no older than he.

Forty years ago the first electric light bulb, illuminated by a current which had been generated in a dynamo and carried through the street by a feeder wire, blazed up in a building in lower New York. The entire apparatus involved was totally new. When the idea of a central station to supply light to an entire district occurred to Mr. Edison he found it necessary, in order to carry the idea into effect, to invent not only the incandescent bulb, but the dynamos that generated the current and the system of feeders that carried it to the bulbs.

40 Years of Growth

The technique of applying electricity to industrial uses has developed so tremendously since that time that it is impracticable even to catalogue the improvements. Telegraphy was virtually the only important application of electricity that in 1882 had reached anything closely resembling its present form. Even that has undergone technical improvements in the past 40 years. Automatic receiving and sending devices have been perfected, relays have been devised to facilitate long-distance transmission of signals, systems of multiplex telegraphy have been invented that greatly reduce the cost of sending messages, and sensitive receiving machines have been constructed that make the operation of trans-oceanic cables efficient and accurate. The telephone, which was in a rudimentary stage when Edison opened his first central station, has been brought to a point of development which could not have been predicted in those days. The latest great development in this field is the automatic switchboard, which practically eliminates the need of "hello" girls. The New York Telephone Co., in co-operation with the Western Electric Co., is now engaged in the gigantic task of installing these machine switchboards which may serve the 1,044,000 subscribers of New York City on August 31, 1922.

The art of converting mechanical energy into electrical energy, transmitting it through wires, and reconverting it to mechanical power to drive machines, has taken enormous strides. The use of electrical power in industry was unknown then; electricity is now one of the chief methods of supplying industrial power, and the further development and application of this technique is one of

(Continued on page 42)

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SANFORD RILEY STOKER CO. WORCESTER, MASS
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PATENT NOTICE.

To all whom it may concern:—

Be it known that CHARLES PRACHE, of Paris, France, is willing to license any Canadian manufacturers under his Canadian Patent No. 203,025, for EVAPORATOR.

Further information may be had by applying direct to me, or to Messrs. Marion & Marion, 364 University Street, Montreal. P.2.H

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STATIONARY ENGINEER — SECOND CLASS, requires position, ten years' experience of steam generation, refrigeration, cold storage and electric generation, thoroughly experienced with heating systems and hydraulics and all classes of stationary engines, used to large plants, good references. Apply to Box 5122. P.3H.

FOR SALE—FLUE GAS THERMOMETER, Vapour Pressure Type. Range 0 to 1000 degrees Fahrenheit. Dial 8" Diameter. Complete with 15 Ft. of Flexible Tubing. Price $25.00. Write Power House, Box 150.

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JARDINE AND TOLEDO PIPE THREADING tools; also blacksmiths', machinists' and boilermakers' tools; get a catalogue and specify your needs; it pays to use the best tools. A. B. Jardine and Company, Limited, Hespeler, Ont.

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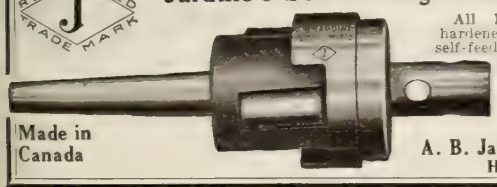
REGISTERED J TRADE MARK
Jardine's Self-feeding Tube Expanders



All have properly case-hardened bodies and are self-feeding and self-releasing. By reversing position of mandrel, it is withdrawn without danger of breaking mandrel or straining expander.

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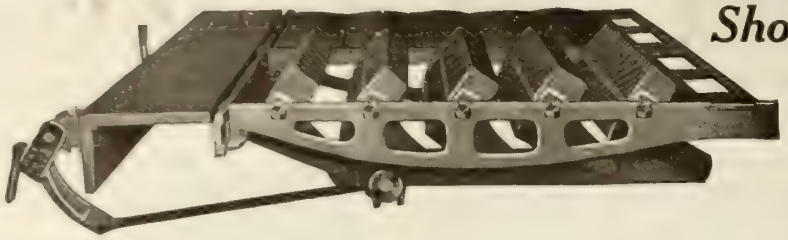

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Sole Makers for Canada

20 McGee Street PHONE: G. 3660 Toronto, Ont.

WE GUARANTEE that with the use of CYCLONE SHAKING AND DUMPING GRATE any grade of hard or soft coal, **or screenings of same,** can be burned with excellent results both as regards Economy and Capacity; that the total annual expense to the user for coal, interest, depreciation, repairs, damage to boiler, liability of shut-down, etc., will be much less than would be the case with any other type of Grate or Stoker on the market.

40 YEARS OF GROWTH

(Continued from page 40)

the chief problems of our future industrial development. It is a long step from Edison's first central station to the super-power plant to supply the entire North American seaboard from one great transmission line; yet that is the stride which has been taken in 40 years.

How Far Will it Go?

The devices for the use of electricity in the home and the factory for other purposes than the production of power and light and the transmission of messages are myriad. The electric furnace—to mention only one of them—has made possible the attainment of unbelievable high temperatures. One other paramount development must be mentioned—radio.

The transmission of telegraphic signals and human speech through the ether is a source of perpetual wonder. The radio has been responsible for the mushroom growth of a branch of the electrical industry in the United States that has attracted as high as $5,000,000 of new capital in a single week.

The electrical industry which has grown up since 1882 enters into every part of our home and industrial life. It runs our machines, lights our homes, carries our messages, and amuses us. But it is still young. No one could have predicted 40 years ago how vast would be the application of electricity to-day; no one can predict the situation 40 years in the future. One thing only can be said with certainty—we have seen only the beginnings of electrical development. The use of electricity will grow, perhaps, to a more vast extent than we can now imagine.

—From The Industrial Digest.

A VALVELESS PUMP

Every user of a reciprocating pump knows the endless trouble which arises in connection with the valves. However carefully these are designed and however well they are manufactured, they sooner or later require replacing or repairing owing to the heavy strain which is placed on them. With these difficulties in view countless inventors have tried to make a reciprocating pump without valves; but complete success seems to have been reserved for a British engineer. His pump has no valves and is so constructed that its cylinders fill and discharge completely on every stroke thus giving the highest possible efficiency. The only parts liable to repair or replacement are those employed in the driving head, and they are all easily accessible and are standardized at slight cost. The materials used are specially selected to ensure the maximum of wear. During a test recently carried out on a six-inch pump driven by a one horse-power motor, 5,000 gallons of water were pumped per hour against a head of about six feet.

COAL BRIQUETTING MADE PERFECT

The advantages to be derived from compressing coal dust into solid blocks of fuel have been recognized for many years, and briquettes of this type are in use for a great variety of purposes. Hitherto they have all suffered from the drawback that a large amount of tarry binding material has been used in order to consolidate the dust; and this binding material gives a smoky flame and prevents the briquette from burning brightly. This drawback is completely overcome in a new briquetting system invented by a British company and recently tested with complete success. Ground-up coal is mixed with about half the quantity of water and placed in a special form of press which squeezes out practically all the water. The water, in fact, comes out as a clear jet, and the briquette itself is produced in a compact shape with a more or less hard surface. Within a few hours the briquette is so hard that it can be thrown about without breaking. The amount of binding material required is only about one third of that usually employed and its fuel value is consequently much superior. When burned this fuel opens out well in the fire and burns brightly. Experts declare that this invention marks a revolution in the briquetting industry. Both in capital cost and in working expenses the new system is cheaper than its rivals.

BOOK REVIEW

We have received from the D. Van Norstrand Co., New York, a copy of the third edition of "Mechanical Laboratory Methods" by Julian C. Smallwood, M.E. In this edition the work has been brought thoroughly up to date, and the Definitions and Values Code of the A.S.M.E. Power Test Committee has been included in the work. The book goes into methods of testing practically every mechanical device used in power plant work, and shows how these different instruments must be calibrated before commencing tests. The title is somewhat apt to make the operating engineer think the book is too much of a test engineer's book to suit him, but this is not the case. It should be of the greatest use to any operating engineer as well as to the man whose vocation is purely that of the efficiency engineer. The volume is published at $3.50 in the U. S.

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DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES.

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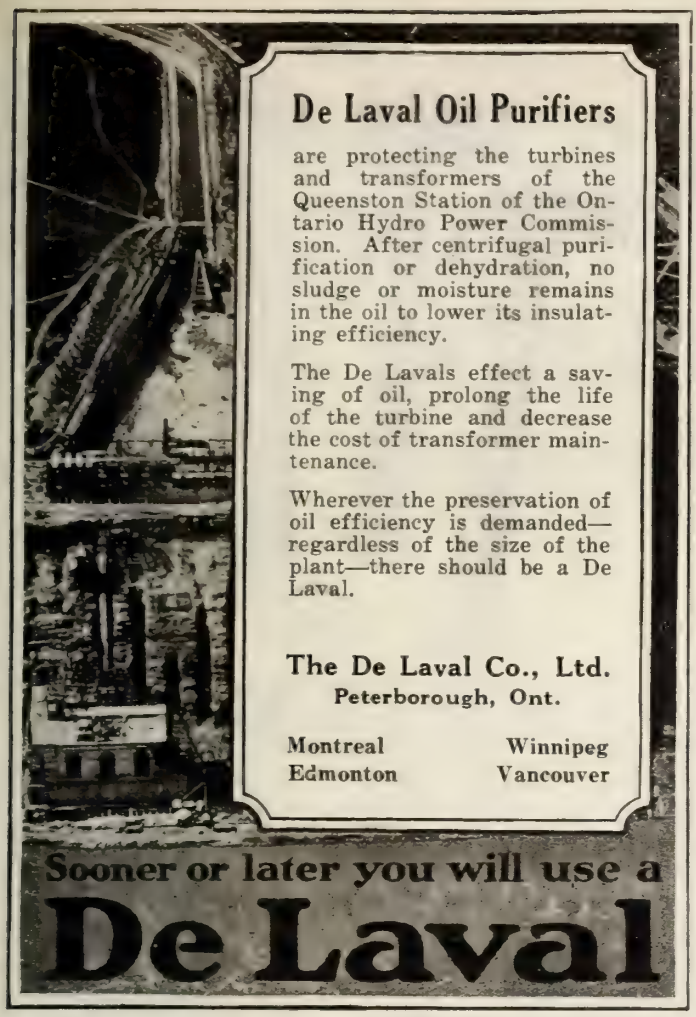

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are protecting the turbines and transformers of the Queenston Station of the Ontario Hydro Power Commission. After centrifugal purification or dehydration, no sludge or moisture remains in the oil to lower its insulating efficiency.

The De Lavals effect a saving of oil, prolong the life of the turbine and decrease the cost of transformer maintenance.

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Try a Magnolia lining on your next hot-box or "hopeless" case and you will quickly see why so many of our customers would use no other bearing metal even if others could be had for nothing.

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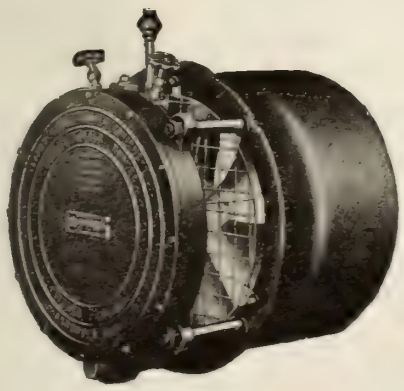
REGISTERED **COPPUS** U.S. PAT. OFFICE
TURBO BLOWER



Solve the Coal Shortage Problem

YOU can adopt no more effective means to meet fuel shortage than by installing Coppus Turbo Blowers. They make it possible to burn low grade fuel with satisfactory results. Because of this and many other economies effected by their use many of Canada's largest plants have adopted Coppus equipment. To wit:

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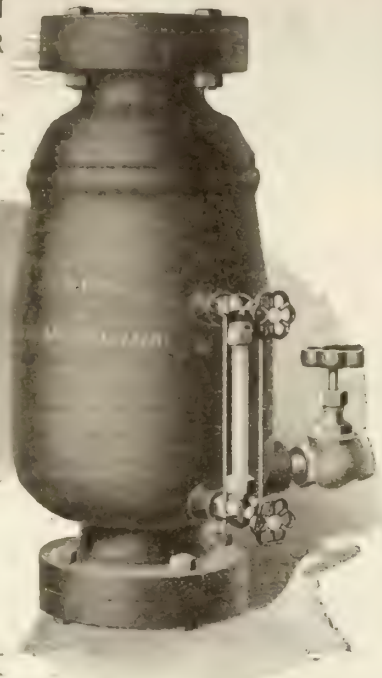

[illegible] a positive insurance against engine breakdowns due to accumulated moisture in engine cylinders and turbine casings. It is an insurance against expensive idleness of both engine and men.

The Anderson delivers dry steam under all operating conditions.

The moisture is completely separated by the combined action of centrifugal force and the sudden reversal of high velocity steam current—and the moisture cannot be picked up again, when once separated.

You really need the Anderson—Let us tell you more about it.

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And there are no better tools than

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SUPERIOR DROP-FORGED HAMMERS

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Build permanent, properly flared one-piece boiler arches and walls without any bricks to fall out. Betson's Plastic Fire Brick eliminates frequent shutdowns for repairs, prevents inleakage of cold air. Any man can build one-piece arches and make perfect furnace linings with Betson's Plastic Fire Brick.

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Canadian Distributors:

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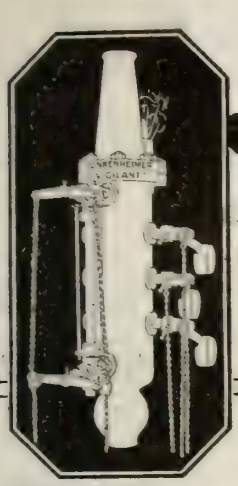

Sounds an alarm

—when danger is near

LUNKENHEIMER

"Vigilant" Safety Water Column

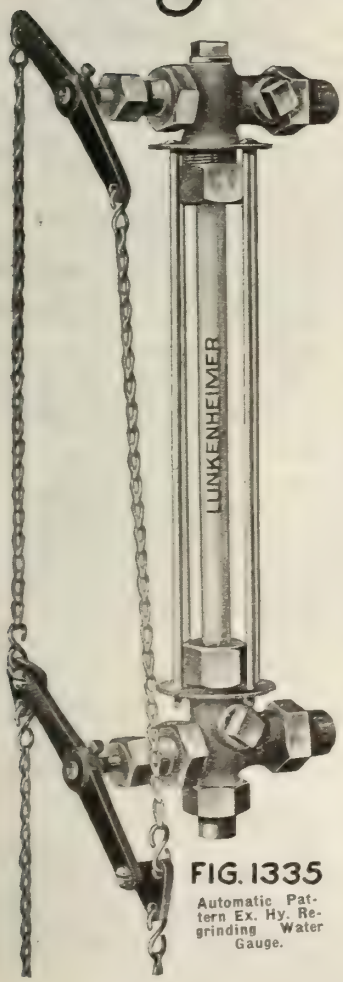

FIG. 1335

Automatic Pattern Ex. Hy. Regrinding Water Gauge.

A safety device as essential for the protection of the boiler against extreme high or low water levels as the Pop Safety Valve is against excessive steam pressure.

The Lunkenheimer "Vigilant" Safety Water Column sounds an alarm before the water reaches either danger limit. It thereby aids in protecting the boiler against accident and in safeguarding the boiler attendants against injury or death and the plant from destruction.

Statistics covering boiler accidents will prove the desirability—yes, necessity—of equipping boilers with the Lunkenheimer "Vigilant" Safety Water Column.

For working steam pressures up to 250 lbs., with a size to fit every boiler, and a variety of Water Gauges and Gauge Cocks available to meet individual requirements.

ASK FOR BOOKLET 519-DC.

FIG. 919

"Vigilant" Safety Water Column.

FIG. 1264

Ex. Hy. "Renewo" Gauge Cock.

THE LUNKENHEIMER CO.

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BEARINGS
Kerr Engine Co., Walkerville, Ont.
Philadelphia, Pa.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

BELT CEMENT
D. K. McLaren Limited, Montreal, Que.

BELLS
Jas. Morrison Brass Mfg. Co., Toronto.

BELT CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

BELT DRESSING
D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

BELT FASTENERS
D. K. McLaren Limited, Montreal, Que.

BELT HOIST
Can. Mead-Morrison Co., Ltd., Montreal.

BELT LACING, LEATHER
D. K. McLaren Limited, Montreal, Que.

BELT HOOKS
D. K. McLaren Limited, Montreal, Que.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford.

BELTING, BALATA
D. K. McLaren Limited, Montreal, Que.

BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
Gutta Percha & Rubber Co., Limited.

BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren Limited, Montreal, Que.

BELTING LINK
D. K. McLaren Limited, Montreal, Que.
Waterous Engine Works Co., Brantford.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
D. K. McLaren Limited, Montreal, Que.

BELTING, ORE ELEVATORS
Gutta Percha & Rubber Co., Ltd.

ARCHES
Can. Fairbanks-Morse Co., Ltd., Montreal

BELTING, FABRIC
D. K. McLaren Limited, Montreal, Que.

BELTING, RUBBER
Canadian Johns-Manville Co., Ltd., Toronto
Can. Consol. Rubber Co., Ltd., Montreal.
Gutta Percha & Rubber Limited, Toronto.
D. K. McLaren Limited, Montreal, Que.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, STITCHED COTTON
D. K. McLaren Limited, Montreal, Que.

BELTING, SOLID WOVEN
D. K. McLaren Limited, Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

BINS, COAL, COKE AND ORE
Waterous Engine Works Co., Brantford.

BLOWERS
The Mason Regulator & Eng. Co., Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co, W. R., Toronto

BLOWERS, CENTRIFUGAL
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty, Ltd., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINE
Canadian Sirocco Co., Ltd., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

CORD CLOTHING
D. K. McLaren Limited, Montreal, Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd. Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto
J. A. Carruthers, Toronto, Ont.
Sexton Boiler Setting Co., W. R. Toronto.
Shell-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto.
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. A., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co.

BOILER SETTINGS
Beveridge Supply Co. Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Sexton Boiler Setting Co., W.R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCullough Co., Galt.
Leonard & Sons, Ltd. E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Setting Co., W. R., Toronto.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd, Toronto.
Gelinas & Pennock, Reg'd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co. Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford.

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg Co., Ltd., The
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren Limited, Montreal, Que.

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N. Y.

CLEANERS, BOILER TUBE CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
R. C. Miler Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West Toronto.
MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville
Mackinnon Steel Co., Ltd., Sherbrooke Q.
Waterous Eng. Works Co., Brantford, Ont.

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Plibrico, the jointless fire brick, is the universal lining for furnaces of every size, new and old. This superior furnace lining is a plastic refractory that can be molded to conform to any furnace design by anyone who can use a mallet and trowel. When vitrified it forms a setting that is solid as rock, resistant to furnace temperatures up to 3,100 deg. F., and above all is jointless.

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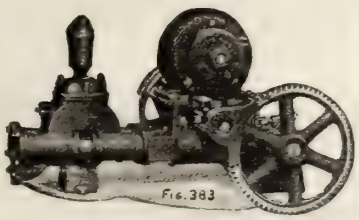

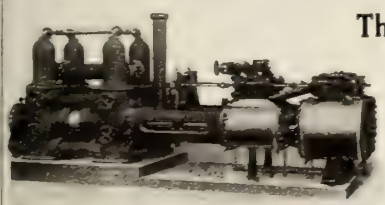

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Builders of Pumping Machinery
Cincinnati, Ohio, U. S. A.

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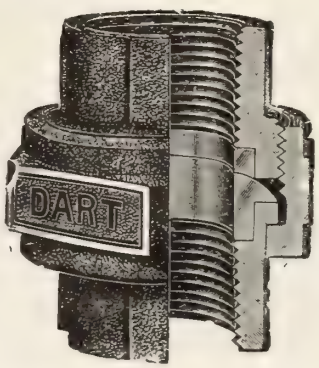
DART UNIONS



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HAVE A
Bronze to Bronze Ball Shaped Joint

Because of this feature, the Dart cannot deteriorate at the vital part, and is easily connected whether pipes are in or out of line.

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COLD STORAGE DOORS AND WINDOWS
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Arthur S. Leitch Co., Ltd., Toronto.
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, ue.
The John H. McGowan & Co., Cincinnati, Ohio
Waterous Engine Works Co., Brantford.

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONCRETE HARDENERS AND DUST PROOFERS
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CONDUITS
Canadian Johns-Manville Co. Ltd., Toronto

CONDENSATION RECEIVER
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CONNECTIONS, FLANGED
Dart Union Co., Ltd., Toronto, Ont.

CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

CONTRACTORS' STRUCTURAL STEEL
Can. Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon Steel Co., Sherbrooke, Que.
Can. Fairbanks-Morse Co., Ltd., Montreal
Babcock & Wilcox, Ltd., Montreal.

CONVEYORS AND EQUIPMENT
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Godfrey Conveyor Co., Elkhart, Ind.
M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

COOLER DOORS
Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaffer & Budenberg Mfg. Co., Brooklyn, N. Y.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co. Ltd., Montreal

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch, Ltd., Galt.
Leonard & Sons, Ltd., E., London, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto
Northern Crane Works, Walkerville, Ont

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, LOCOMOTIVE
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville.

CRANES, OVERHEAD TRAVELING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Babcock Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal.

DIAPHRAGM, PULP SCREEN
Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

DISTILLING APPARATUS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

DOORS, COLD STORAGE AND FREEZER
Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaffer & Budenburg Mfg. Co., Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP- FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

DRYING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg., Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

ELECTRICAL ACCESSORIES AND MACHINERY
Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal
B. F. Sturtevant Co., Boston, Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
MacKinnon Steel Co., Ltd., Sherbroke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co., of Canada, Ltd, Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg., Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Leonard & Sons, Ltd., E., London, Ont
Waterous Engine Works Co., Brantford

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F. Toronto, Can.

EXHAUST HEADS
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXHAUST RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N.Y.

EYE BOLTS

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F. Toronto, Can.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Laurie & Lamb, Montreal.

FILTERS
Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Graver Corp., East Chicago, Ind.
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittsburgh, Pa
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal.
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

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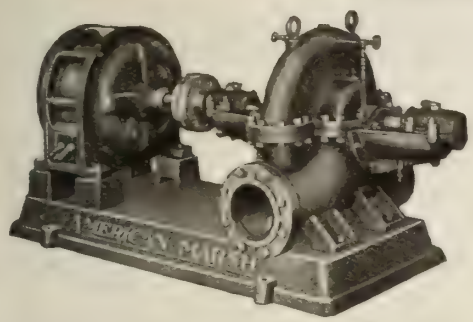

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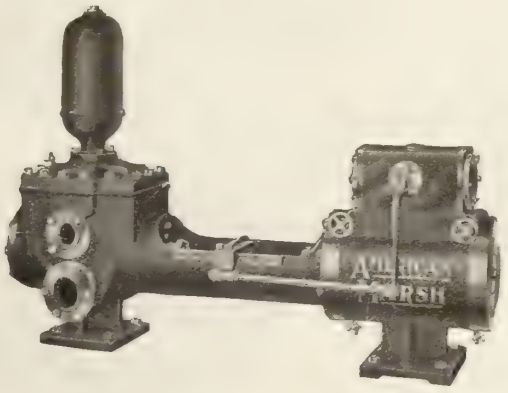

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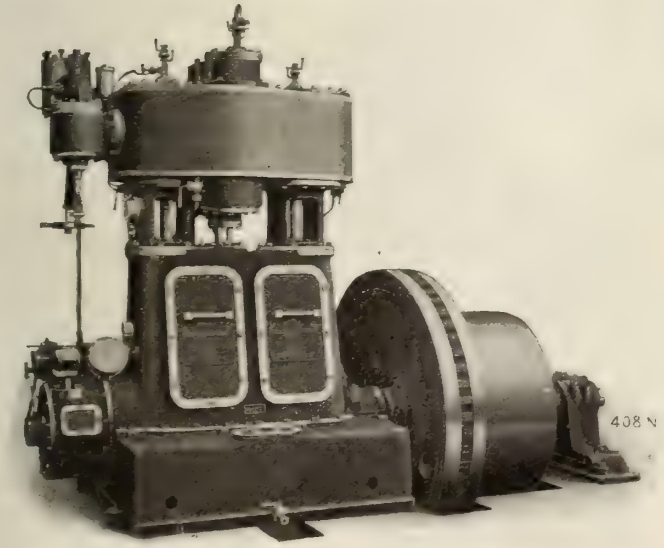

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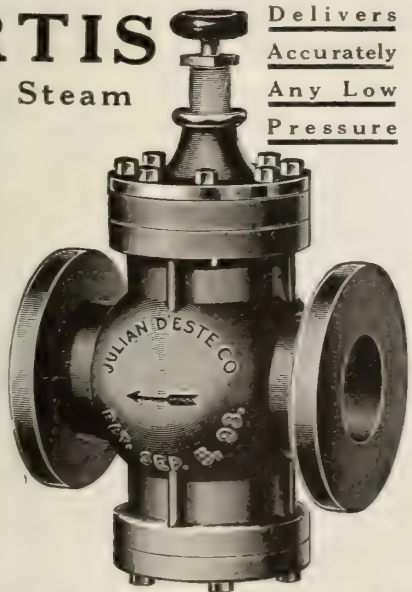

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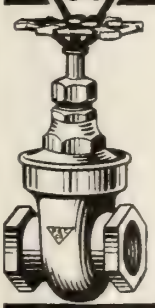

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Boving Hydr. & Eng. Co., Ltd, Lindsay
Goldie & McCulloch Co. Galt
Laurie & Lamb, Montreal.
Mason Reg. & Eng. Co., Ltd., Montreal.
Pratt & Cady, Hartford, Conn
Smart, Turner Co., Hamilton, Ont.
[illegible] Brantford

PUMPS, CIRCULATION

Smart Turner Co., Hamilton, Ont
Laurie & Lamb, Montreal

PUMPS, DUPLEX

The John H. McGowan & Co., Cincinnati, Ohio.

PUMPS, ELECTRICAL

American Steam Pump Co., Battle Creek
Laurie & Lamb, Montreal.
The John H. McGowan & Co., Cincinnati, Ohio
Pratt & Cady, Hartford, Conn.

PUMPS, FEED WATER

Goldie & McCulloch Co., Galt
Laurie & Lamb, Montreal.
Pratt & Cady, Hartford, Conn.

PUMPS, GAS

Smart-Turner Machine Co., Hamilton.

PUMP GOVERNORS AND REGULATORS

The Fisher Governor Co., Inc., Marshalltown, Iowa.
The John H. McGowan & Co., Cincinnati Ohio
D'Este Co., Julian, Boston, Mass.
The Garth Co., Montreal.
Smart-Turner Machine Co., Hamilton.
Under-Feed Stoker Co., of Canada, Ltd., Toronto, Ont.

PUMPS, HAND AND POWER

Boving Hydr. & Eng. Co., Ltd., Lindsay.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.
The Fisher Governor Co. (Inc.) Marshalltown, Iowa

PUMPS, GEARED, COMPOUND

American Steam Pump Co., Battle Creek.
Can. Fairbanks-Morse Co., Ltd., Montreal

PUMPS, HYDRAULIC, PRESSURE

Smart-Turner Machine Co., Hamilton.
American Steam Pump Co., Battle Creek
Boving Hydr. & Eng. Co., Ltd., Llindsay.
The John H McGowan & Co., Cincinnati, Ohio
Pratt & Cady, Hartford, Conn.

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Can. Detroit Lubricator Co., Walkerville.
The John H. McGowan & Co., Cincinnati, [illegible]
[illegible] Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, POWER

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[illegible] & Eng. Co., Ltd., Lindsay.
[illegible]-Morse Co., Ltd., Montreal
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt
Pratt & Cady Co., Inc., Hartford, Conn.
[illegible] Brantford

PUMPS, STEAM TURBO

[illegible]
The John H. McGowan & Co., Cincinnati.

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[illegible] Montreal
Goldie & McCulloch Co., Galt
Laurie & Lamb, Montreal

Leitch Co., Arthur S., Toronto, Ont.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, TRIPLEX

Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton

PUMPS, VACUUM

American Steam Pump Co., Battle Creek.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John H. McGowan & Co., Cincinnati, Ohio.
Pratt & Cady, Hartford, Conn.
Smart-Turner Machine Co., Hamilton.

PUMPS, (OIL AND GASOLINE) SELF-MEASURING

Yarnall-Waring Co., Philadelphia, Pa.

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Canadian Johns-Manville Co., Ltd., Toronto.
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Vilter Mfg. Co., Milwaukee, Wis.
Linde Can. Refrigeration Co., Montreal
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Sarco Co., Inc., New York, N.Y.

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Taylor Instrument Co., Toronto, Ont.

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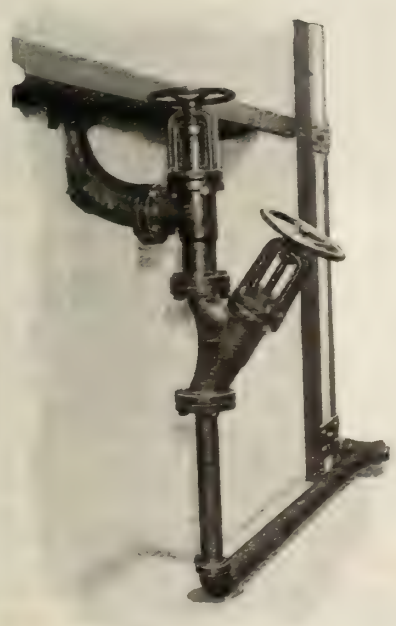

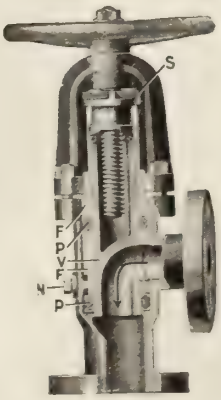

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Shell Bar Boico Co., Walkerville, Ont.
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Shell Bar Boico Supply Co. Ltd., Toronto.
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Lunkenheimer Co., Cincinnati, Ohio.
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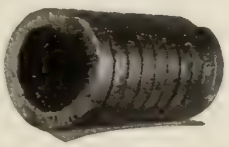

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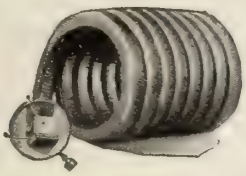

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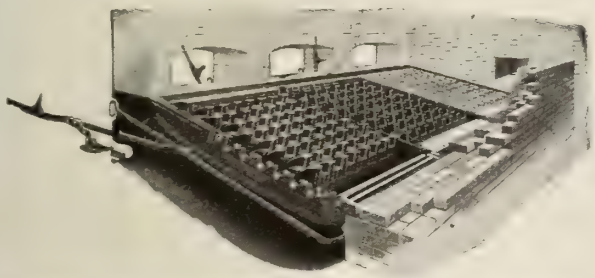
Self Cleaning *Hand Operated*



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INCREASE EFFICIENCY
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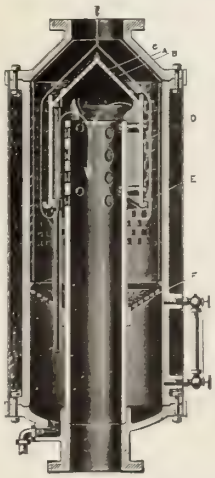

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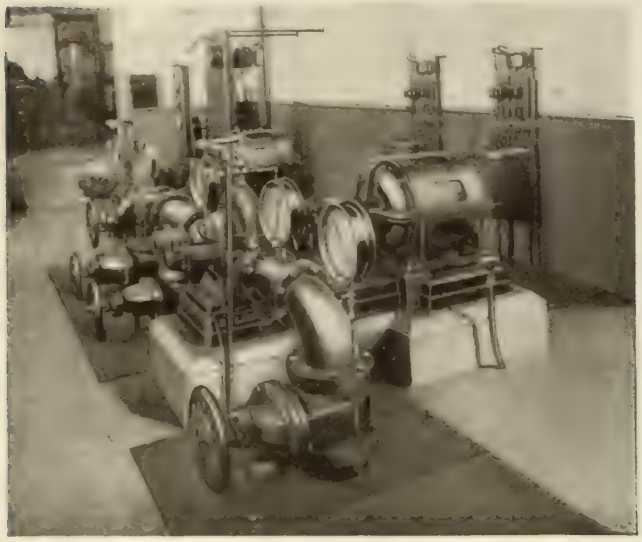

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Efficient — Reliable

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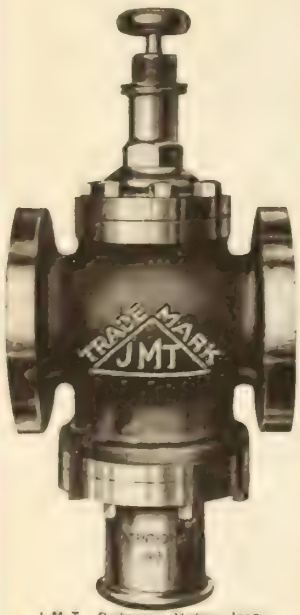

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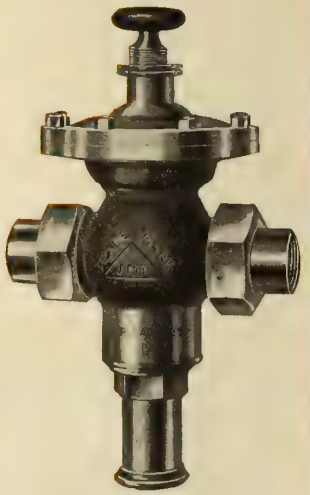

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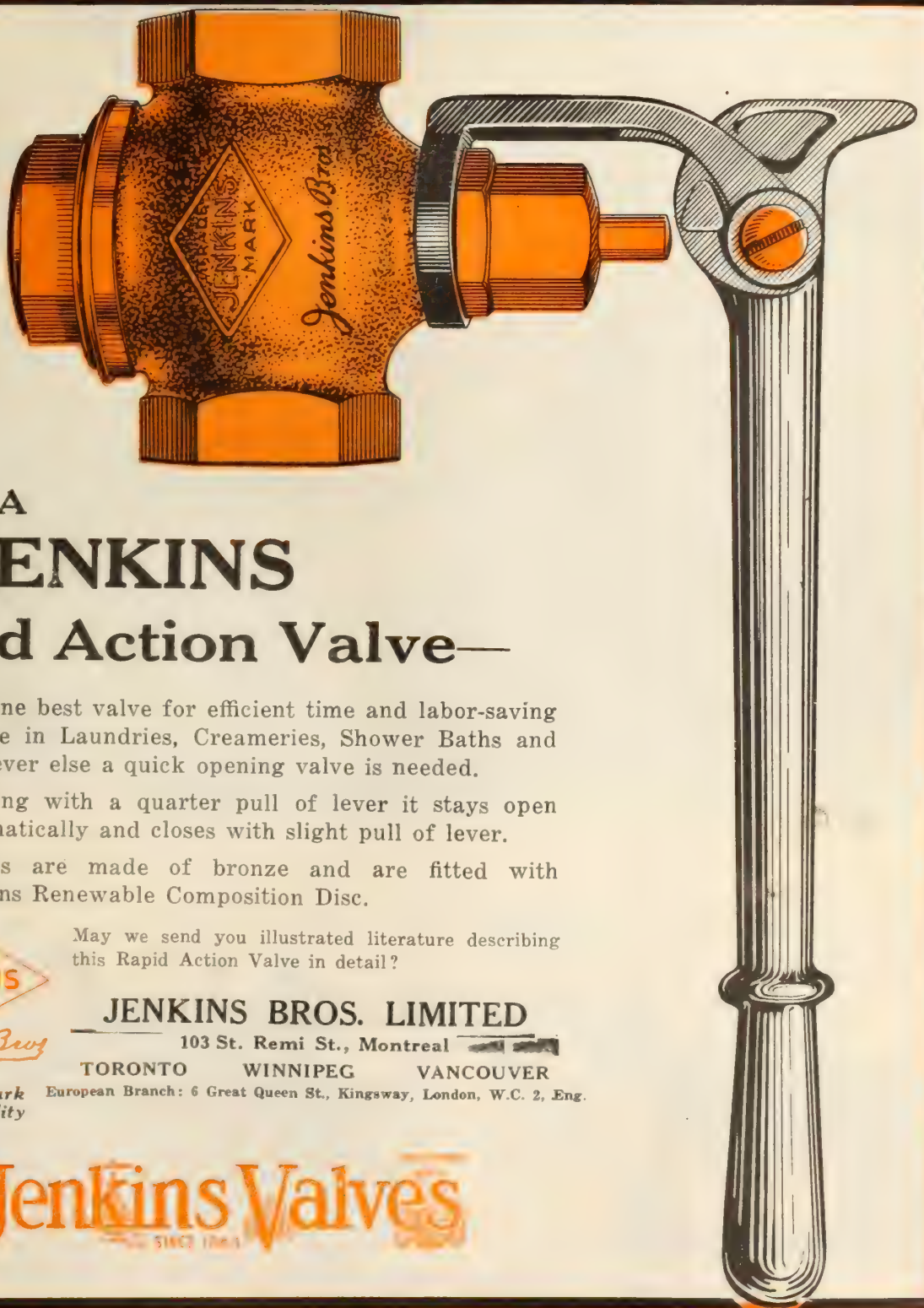

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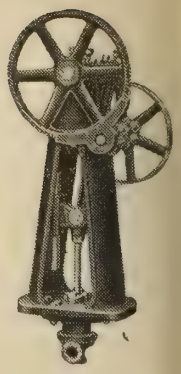

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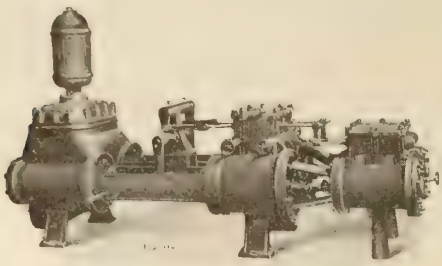
Power



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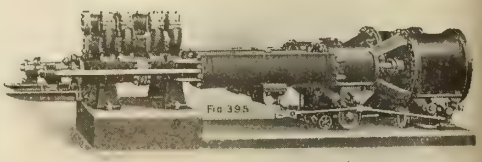

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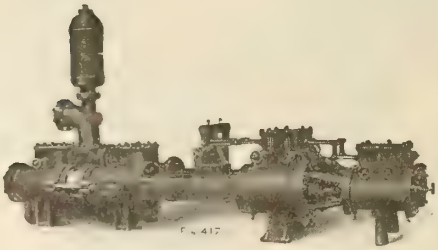

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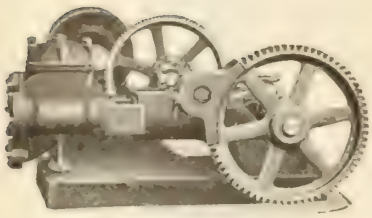
Non-Condensing



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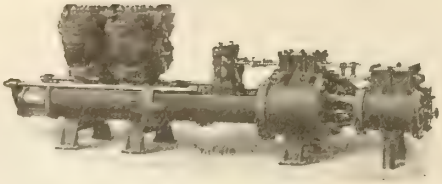

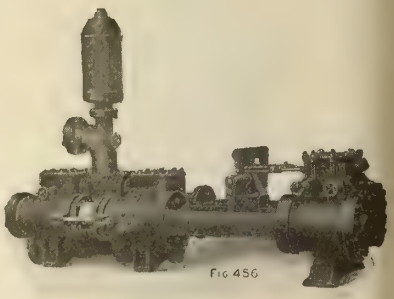

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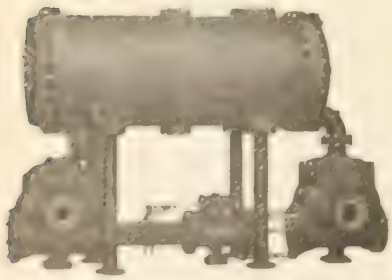

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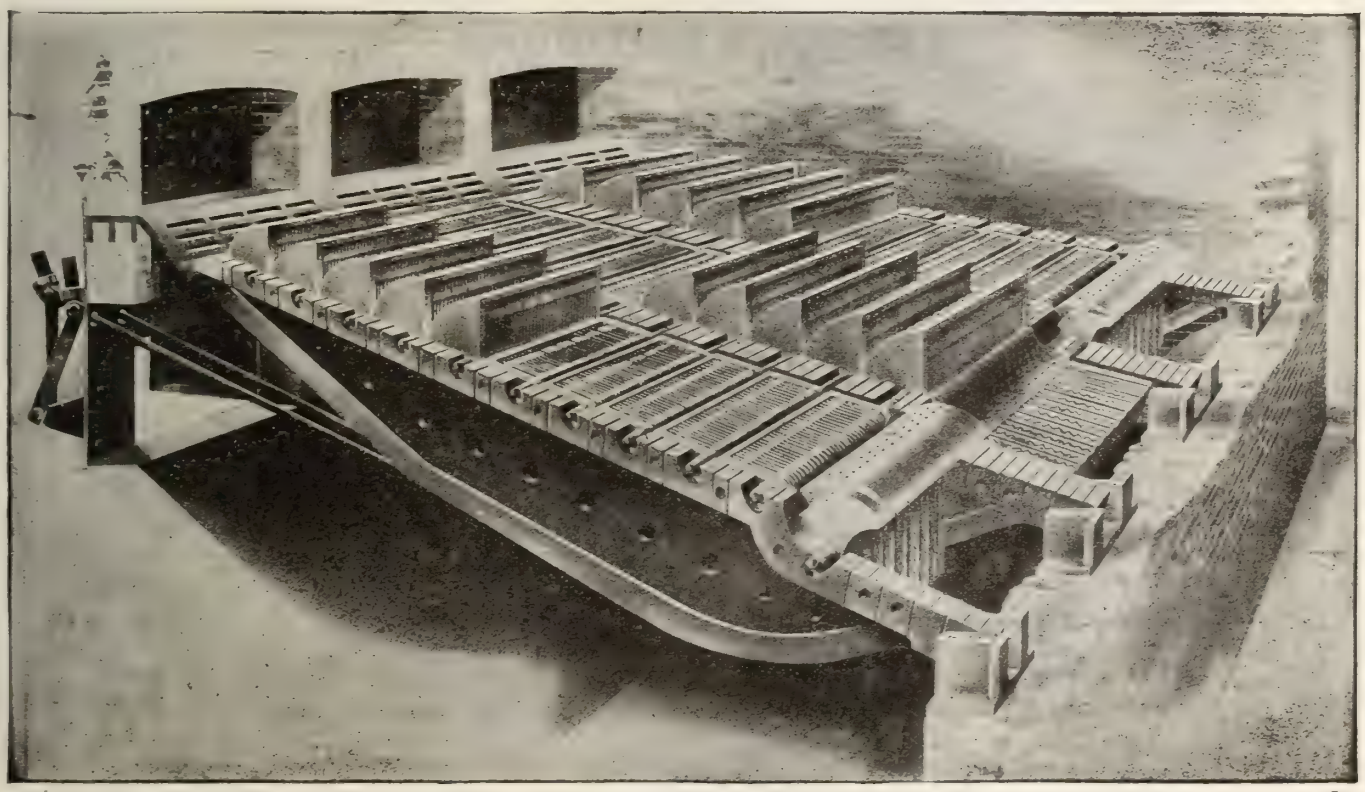

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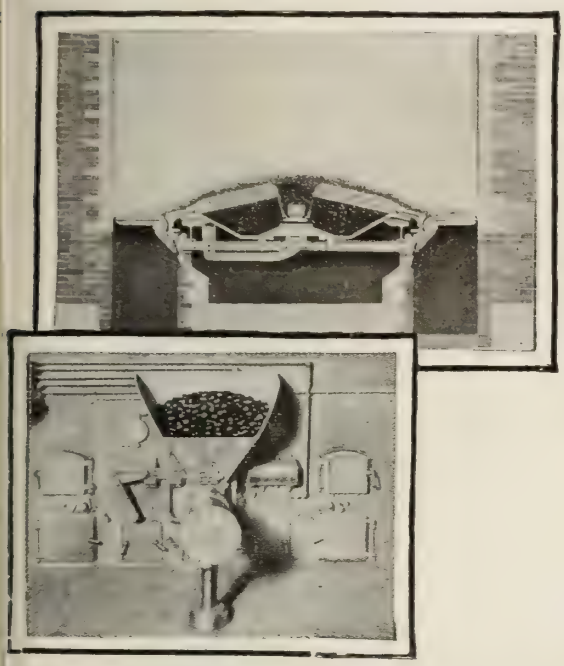

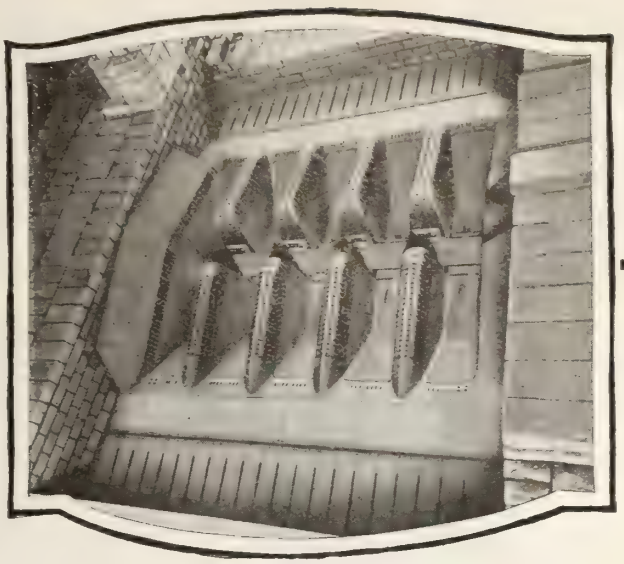

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The views above illustrate the unique design and effective operation. Coal is fed by successive stokes of a ram into the main retort. It is then distributed into the retorts which branch at right angles—the *lateral retorts.*

This method of distributing fuel should not be confused with ordinary side dump stokers in which the coal is overfed from the main retort onto side grates. The coal is *under-fed* in the *lateral retorts* just as definitely as in the main retorts. Consequently it is always thoroughly volatilized and burns as coke.

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COCHRANE

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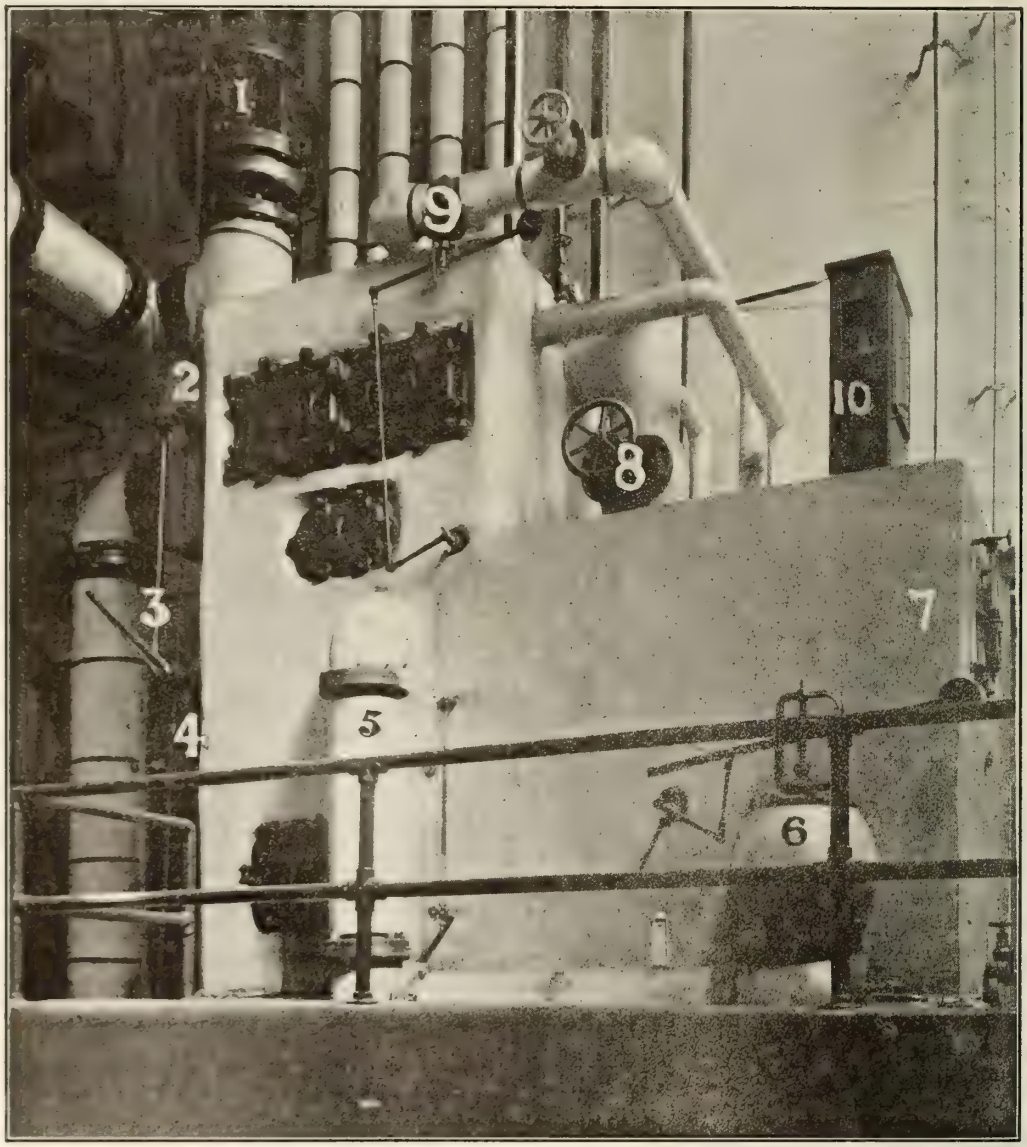
in the Plant of the Toronto Carpet Company



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2. Cochrane Oil Separator with cut-out Valve.
3. Cut-out Valve mechanism.
4. Cochrane Oil and overflow trap.
5. Pipe connecting Heater and Meter chambers; bypass direct from Heater to Pump provided.
6. Equalizing Valve to Meter chamber.
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8. Equalizing Valve connecting Heater and Meter chambers.
9. Balanced cold water regulating Valve.
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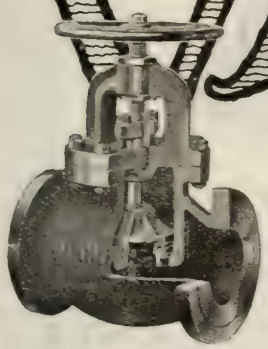

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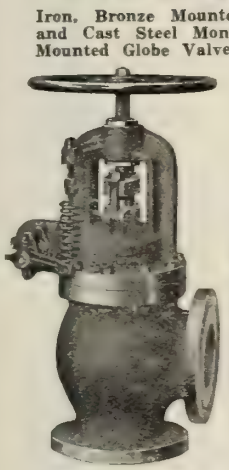
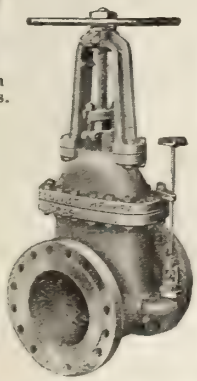
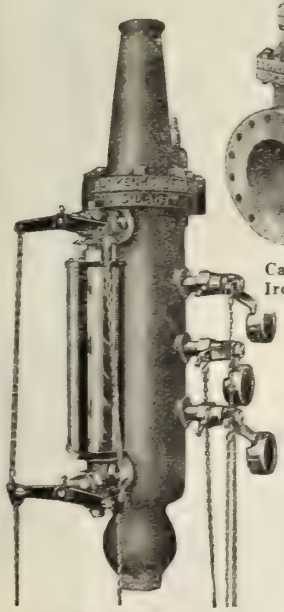


"Duro" Blow-off Valves.

Safety Non-return Boiler Stop Valves.



Cast Steel and Iron Gate Valves.



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Pop Safety Valves.

Bronze Globe Valves.

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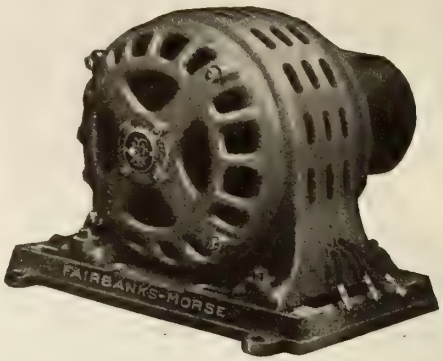

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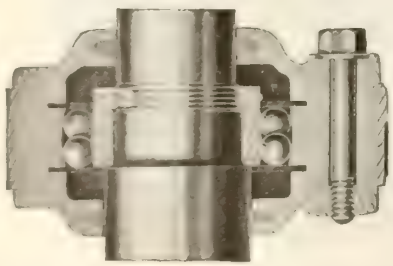

They maintain alignment under the heaviest gear, chain or belt pressure because of the great strength and rigidity of the solid, one-piece frame.

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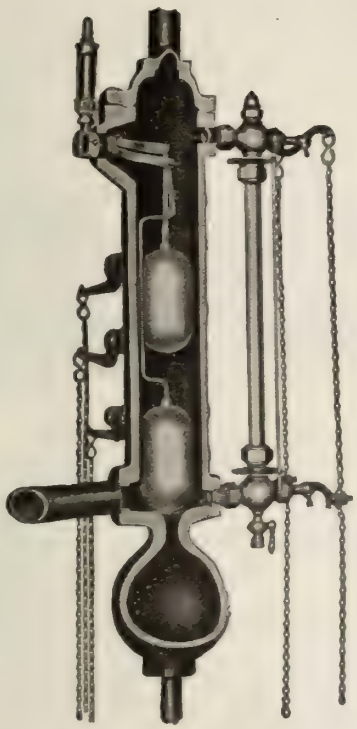
no engineer enjoys the job of reporting why a boiler in his plant has exploded



This shows you the "insides" of the Reliance Column. Our new catalog is fully illustrated with sectional views of this kind. Have you sent for your copy?

WHEN one of your boilers lets go with a vicious roar, smashing the neighborhood into rubbish, there is little personal satisfaction in it for you in making your report on the loss from the accident and the cause of it.

"Low water level, not detected in time."

A Reliance Safety Water Column would have set a whistle shrieking to snap the fireman into action; it would have flashed an electric signal to you to tell you trouble was afoot in the boiler room. There would have been no explosion. Instead, the fireman would have been called to account for letting the water get low enough to blow the whistle.

A Reliance costs so little and gives such dependable, valuable service that you can't afford to be without one on every boiler.

83% are Reliance

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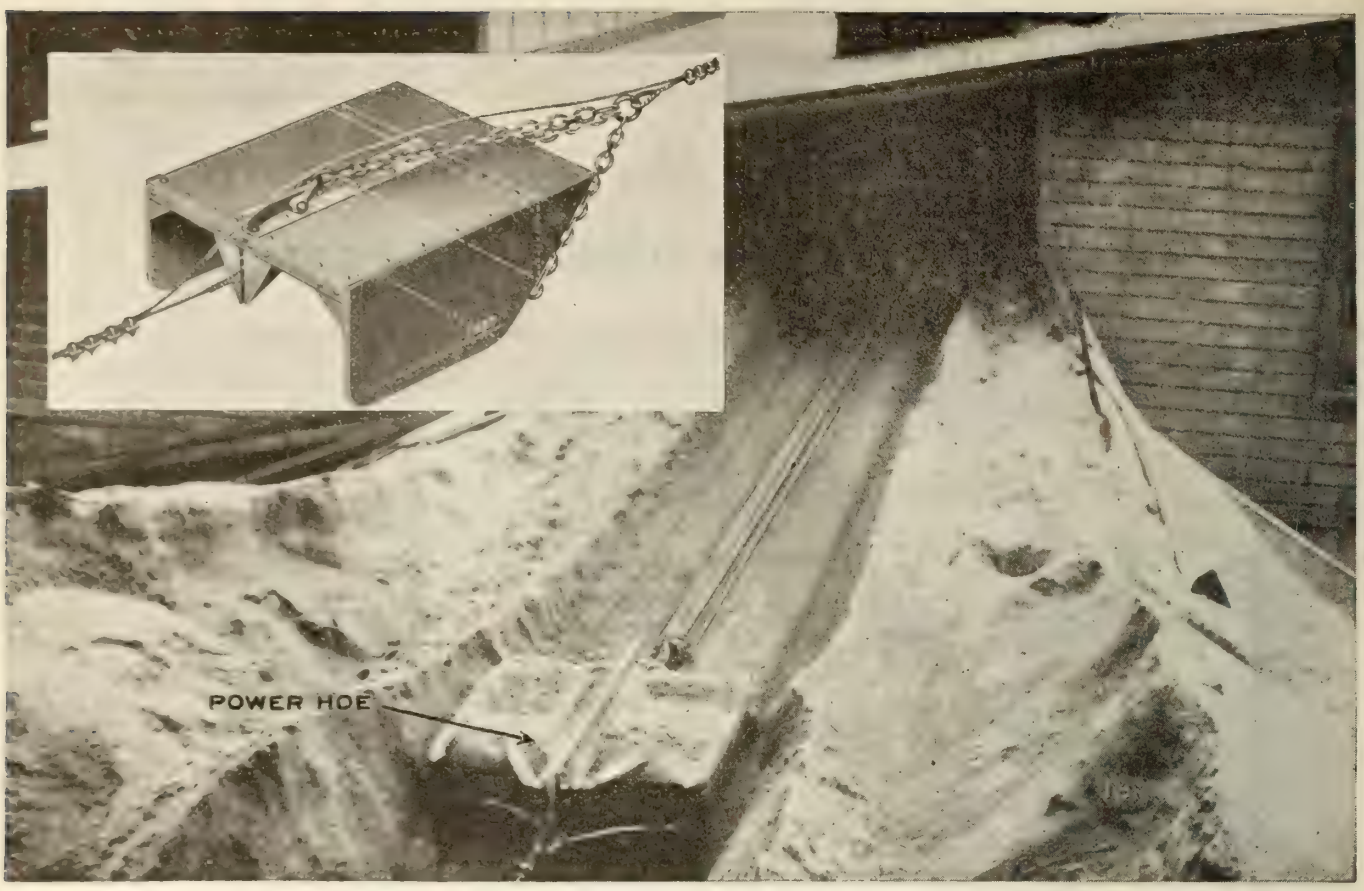

LINK-BELT POWER HOE (IMPROVED DRAG SCRAPER)

The Link-Belt Power Hoe is an effective arrangement for storing and reclaiming coal, sand, gravel, or any loose material in either open or covered storage. It is low in both first cost and operating cost.

It involves principles that are new to this class of implement which not only prevent overloading or "digging in" but also eliminate the necessity of dumping at the end of the haul.

The movable anchor and balanced pulley blocks allow the use of one-third the number of anchor posts required by similar devices of this kind.

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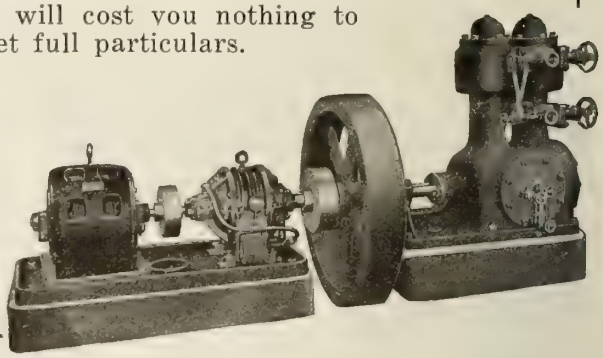

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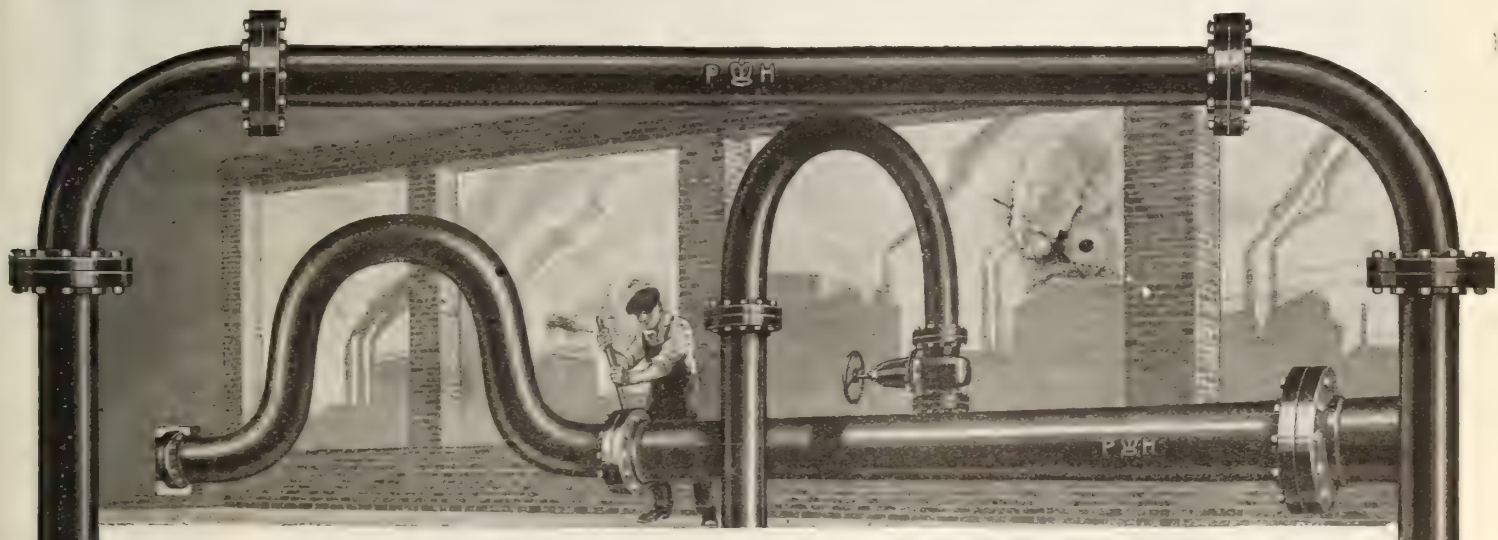

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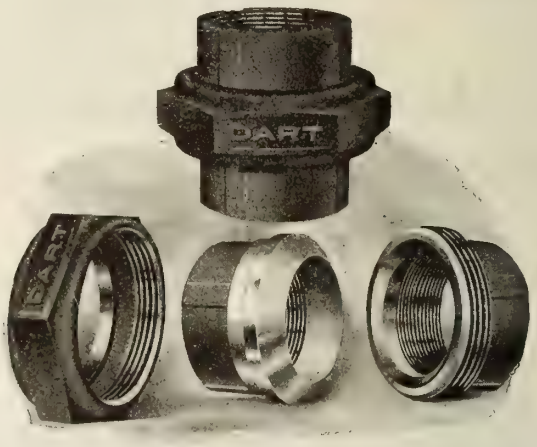

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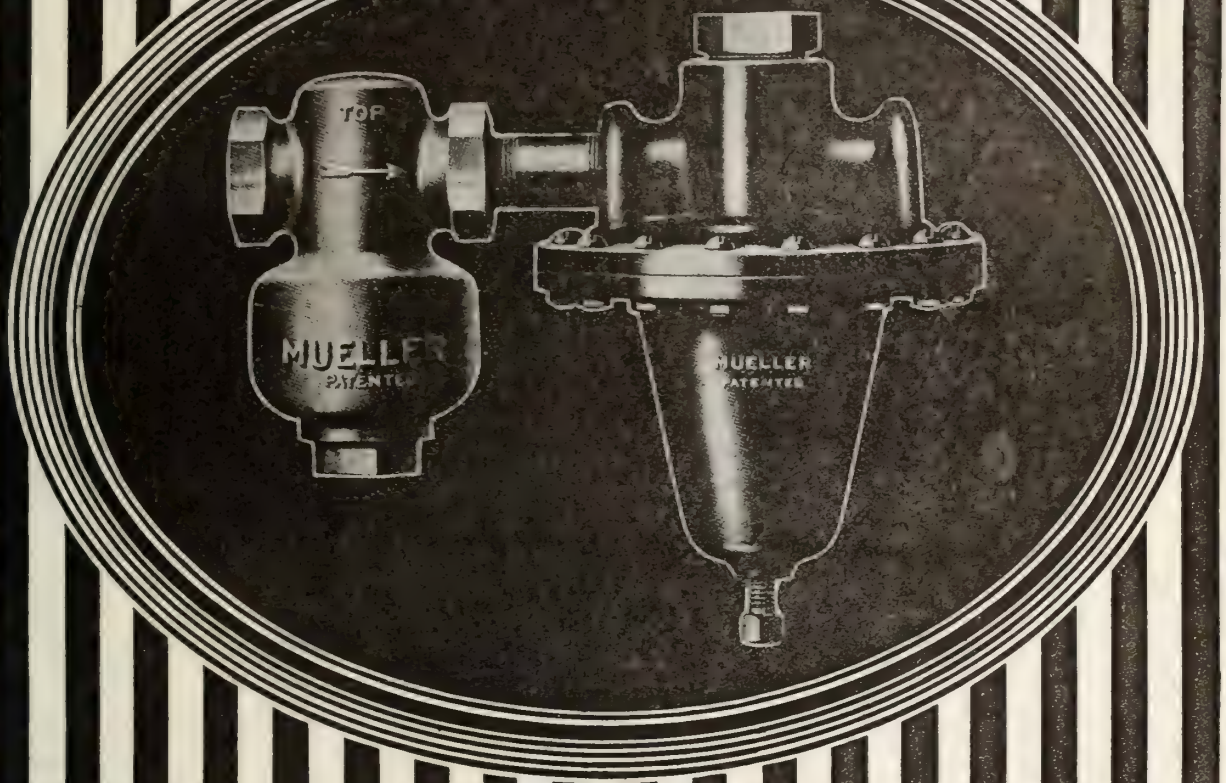

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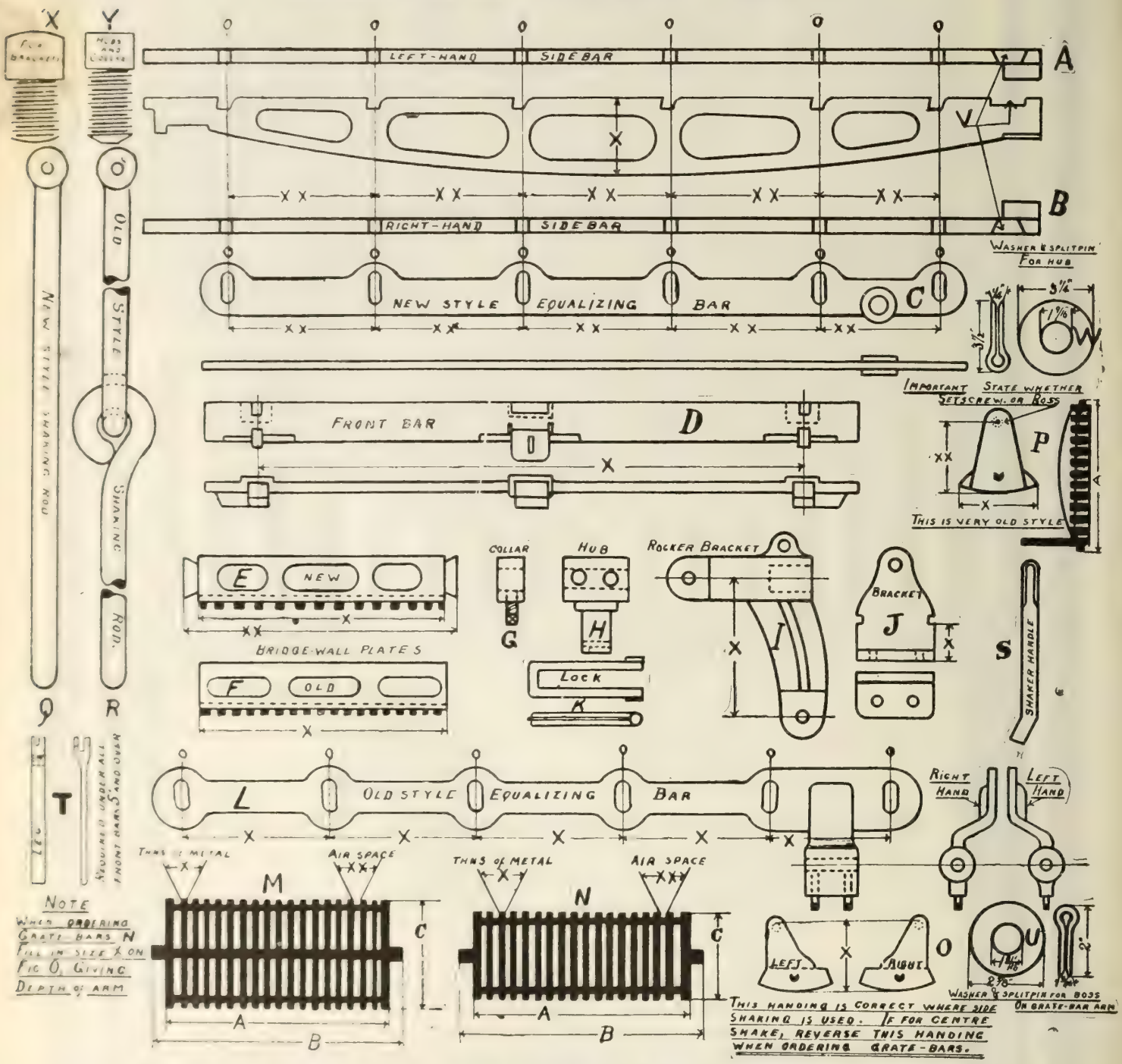

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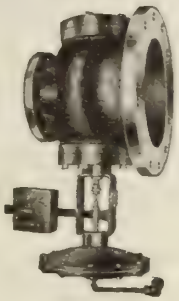

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for instance, have conclusively proven their long-lasting reliability in all parts of the world. No matter what kind of work or what kind of conditions they go quietly and efficiently about their jobs. Dependable, that's what they are!

Fisher Reducing Valve (Type 11-A) is a stock reducing valve with an expanded outlet. These valves are made in a wide variety of inlet and outlet size combinations. We are sure to have one in stock exactly suited to your requirements.

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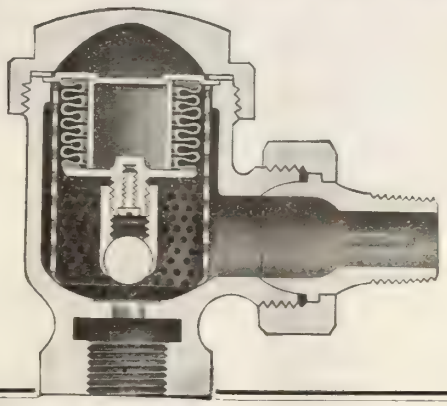

In these days factory owners are inquiring more closely than ever into operating costs. With coal at present high prices, your heating installation will be judged on the saving of fuel effected. And in order that it may operate at 100% efficiency as a whole, it must be properly trapped.

All radiator traps are not alike. To be positive that the condensate will find immediate egress, install the

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The total lift of the ball valve from its seat, about ¼", permits of a free discharge, while its pressure on the valve seat, on return, is such as to prevent the escape of steam.

No other element, either flat disc or corrugated type, has such a long life as the Sarco element, due to the spiral (not annular), corrugations which distribute the valve movement over practically the entire drum. When you install the Sarco you get year-in-year-out durability as well as efficiency.

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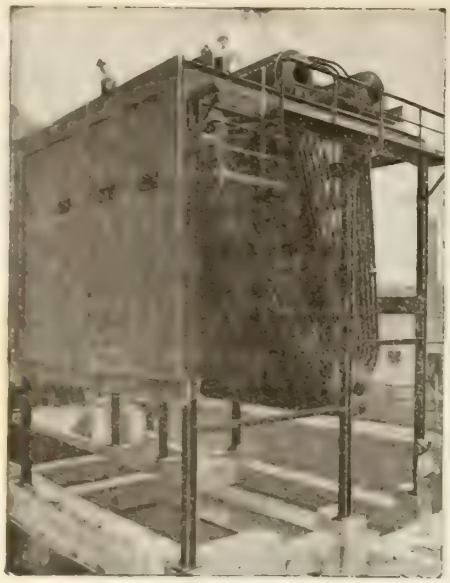

Connelly Water Tube Boilers

are of the 4-drum type; have 100% tube area in the path of circulation, and deliver steam superheated to from 5 degrees to 10 degrees Fahrenheit. Simple in design, no flat surfaces, no stay bolts, no crown bars, no braces, no handholes, free from joints.

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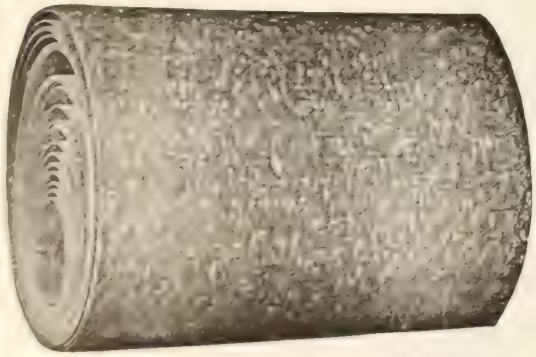

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"Lascar" V Packing is characteristic of this efficiency. It consists of a single V-shaped bar of white metal securely fastened in its cushioning of the highest grade asbestos. It is extremely flexible and exactly takes the shape of all rods. Its continuous bearing surface of white metal reduces friction on the rods to a minimum.

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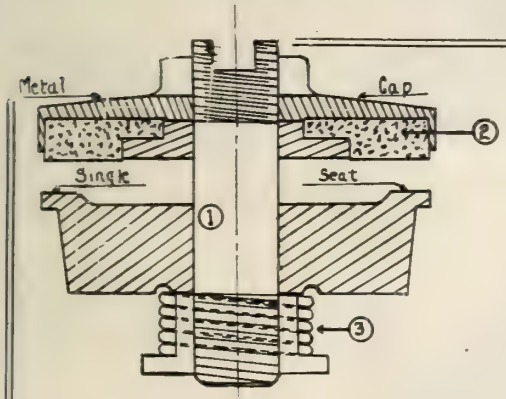

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Perfect seating, maintenance of alignment and durability are assured in this Robinson Pump Valve; as the stem, instead of being fixed with relation to the seat, moves in long bearings of metal to metal.

All working parts consist of metal in contact to metal and all joints where leaks might occur comprise metal in contact with packing.

There are only six parts—less than half the number used in valves of the same type and comparable in efficiency.

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THIS CONCRETE DAM
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CANADA is justly proud of her "white coal." The development of the Dominion's water power has employed the highest skill of the engineering profession—and in this development concrete and reinforced concrete construction have played an important part—both as regards publicly-owned and privately-owned water rights.

Our illustrations are from photos of the Southern Canada Power Company's plant at Drummondville. Quebec.

The top view shows the completed dam—and the arrow points to the location of the Power House.

The lower view illustrates the splendid resisting qualities of concrete. The breaking up of the ice nine days before the completion of the work unexpectedly flooded the dam; yet the structure was uninjured by the severe strain thus suddenly placed upon it.

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Uniformly Reliable

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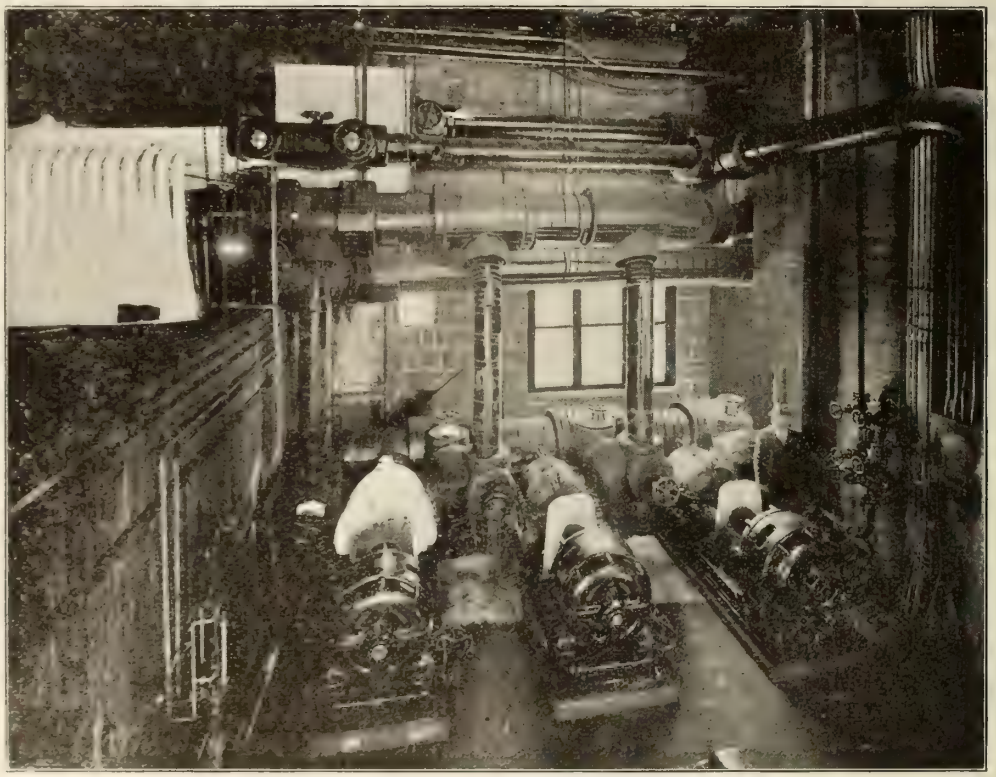

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POWER HOUSE

Members of the Audit Bureau of Circulations

The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Montreal Cold Storage Warehouse Plant

This Plant is Among the Outstanding Examples of Storage for Perishable Goods That Can be Found Anywhere in the World—In Its Construction, Canadian Brains and Material Predominate

THE magnificent Cold Storage Plant now being completed by the Harbor Commissioners of Montreal will be, when completed, one of the finest undertakings of its kind in the world. It will be of national importance to Canada and of great value to the harbor of Montreal.

The plant consists of two buildings; the warehouse where food products from all parts of Canada and certain parts of the United States, in the form of fruits, eggs, cheese, meats, fish, vegetables, etc., will be received, refrigerated and held in suitably-preserving temperatures until shipments abroad or elsewhere are required; and the power house, where all mechanical equipment is being installed for the cooling of the refrigerant necessary to maintain the preserving temperatures in the various cold rooms of the warehouse.

Each building is of very handsome and massive design, of fire-proof construction, and in every way a credit to the harbor. While not having as large a floor area as one or two other cold storage warehouses built during the war, yet this warehouse on the Montreal Harbor front will contain features in connection with its equipment which will place it ahead of any other cold storage warehouse.

After it was decided to build the plant, the Harbor Commissioners engaged the services of Major R. Percy Sims, as Consulting Refrigerating Engineer, who has had a most extensive experience in this class of engineering in all parts of the world. He was personally responsible to the commissioners for the preparation of all the specifications and plans of all the equipment in the plant, and has also personally superintended its complete installation.

In this work, Major Sims' main object was to so design and arrange the plant that it should operate at the highest efficiency, and provide such equipment as would enable the greatest confidence to be established between the owners and shippers of the goods stored in the warehouse and the Harbor Commissioners as the operators of the plant, and to insure against useless and costly litigation, often caused through misunderstanding.

Special Features

There are many special features in connection with the equipment of this cold storage plant which are worth describing. One of the special features is what is technically termed, the air-conditioning of the rooms. In most cold storage warehouses, the condition of the air in the rooms is neglected and, considering that they contain food for public consumption, it is often very impure. Most of the food products stored give off gases, odors, heat, moisture, etc., which if not promptly removed, are

General view of rear of plant showing trackage.

detrimental to the proper preservation of the food. In a few cold storage warehouses the air-conditioning of the rooms has been spasmodic, incomplete and half-hearted, with the result that there is very little data available on the subject under low-temperature conditions. In the Montreal Harbor Cold Storage Warehouse, each room will be equipped so that the air in that room will be changed as often as its contents require and before the air is returned it will be thoroughly washed, brought to the proper humidity, purified by the introduction of a proper quantity of ozone, and slightly reduced in temperature to prevent its condensation as it enters the room. There will be a separate air-conditioning room on each cold storage floor, due to the great difference in the temperatures of the various floors. The introduction of the ozone into the washed air, previous to its return, not only purifies the circulating air but also destroys such germs or impurities as may exist in the room in which it enters. It is believed that this special air-conditioning feature will be fully appreciated by the owners of the goods stored, as soon as they realize its advantages.

Thermometer Installation

Another special feature in the equipment of the warehouse is the completeness of the thermometer installation, relating to the temperature of each of the cold rooms, and also that of the circulating refrigerant. Each room will be equipped with an indicating thermometer, the bulb being placed in a suitable position inside the room, and the indicating dial attached to the division wall of the room in the distributing corridor. This indicating thermometer will be for the use of the floor operator, and will enable him to ascertain the temperature inside the room without entering. In addition to these indicating thermometers there will be a complete system of recording thermometers, with continuous charts, situated in the office of the general superintendent of the warehouse, which will avoid disputes between the owners of the goods stored, and the operator of the building. Many hundreds of thousands of dollars have been paid by cold storage companies, in order to avoid litigation because they have not been able to disprove allegations by the owners of the goods stored that improper temperatures have been maintained. On the other hand, this complete recording system of temperatures will insure a great deal of extra confidence, on the part of the owners of perishable produce using the warehouse, because they will feel that owing to this continuous record being kept greater care will necessarily be exercised by the operators of the warehouse. The contract for this work has been placed with Messrs. Peacock Bros., Ltd., of Montreal.

The only refrigerant to be used in this new cold storage warehouse is a solution of chloride of calcium, of a density which will prevent its congealing under temperatures considerably below the normal temperature required for the refrigerating of the rooms. This calcium chloride solution will be conveyed from the power house to the basement of the warehouse through steel pipes having an internal area of over 170 square inches, from which it is taken to the various cold storage floors through four 8 in. risers, arranged in such a way that the pressure of the supply on each floor is equalized. The cooling of the rooms is accomplished by circulating the solution through 2-inch. galvanized pipe coils suspended from the ceilings, after which it returns to the power house. Several hundreds of thousands of feet of this 2-inch galvanized pipe have been installed in the rooms for this purpose.

A Heating System Necessary

In a cold storage warehouse, it is the popular idea that a heating system is not required, yet in a building of this character there is much space which should be equipped with heating apparatus. In the harbor warehouse, there is a steam heating system which has cost nearly thirty thousand dollars, the steam for which is generated in two Victory water-tube boilers, each of 120 horse-power, made by the Robb Engineering Company of Canada, Amherst, N. S. The whole of the 2nd, 3rd and 8th floors, the offices on the 1st floor and the distributing corridors of the cold storage floors have been completely equipped with a Webster vacuum heating system installed by the Garth Company of Montreal, the special Webster equipment being furnished by Darling Bros., Limited, of Montreal.

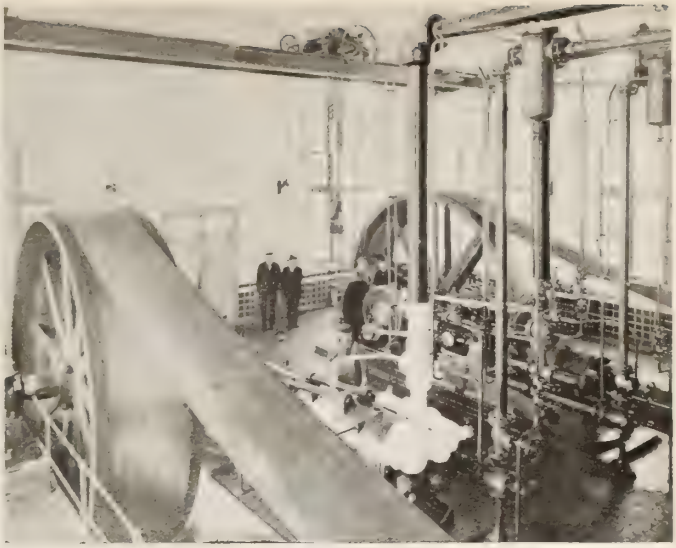
Automatic Sprinklers

Throughout the warehouse there is an automatic sprinkler system. Although the building itself is, practically, fireproof, yet it will contain goods of an inflammable nature and worth millions of dollars. By the installation of an automatic sprinkler system, the insurance rate is so reduced that the entire cost of the installation is paid for in a few years by such reduction, apart from the continuous protection to the building and its contents.

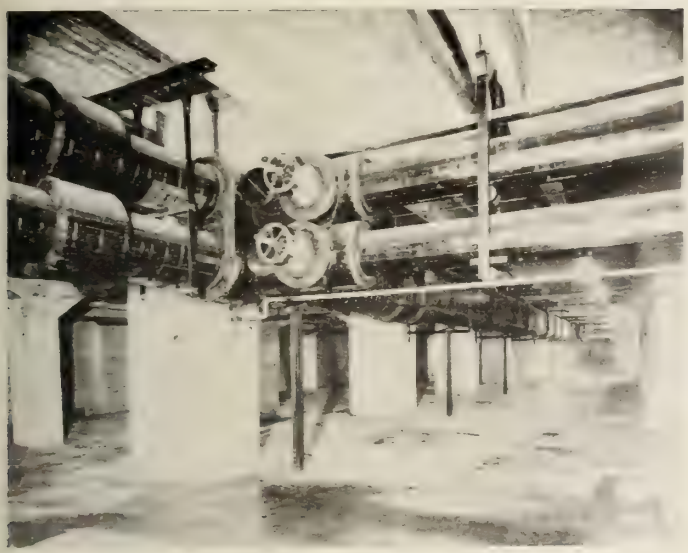
In the past, there has been a consid-

South front of plant—Power house on right.

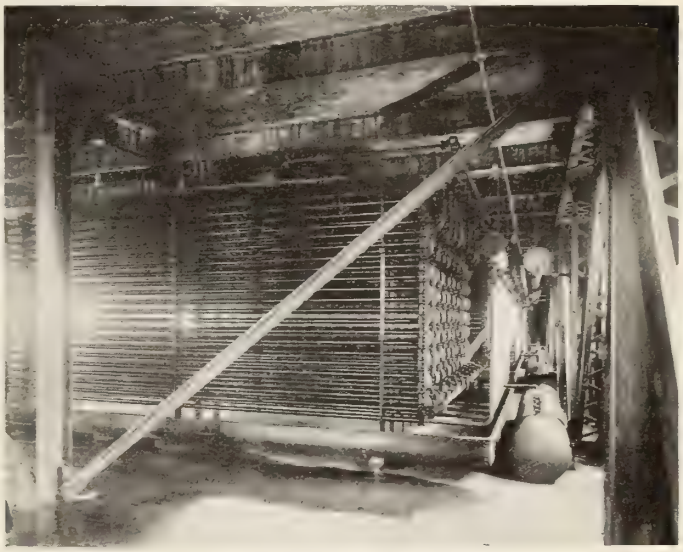
View looking toward west room of power house



View of west room of power house.

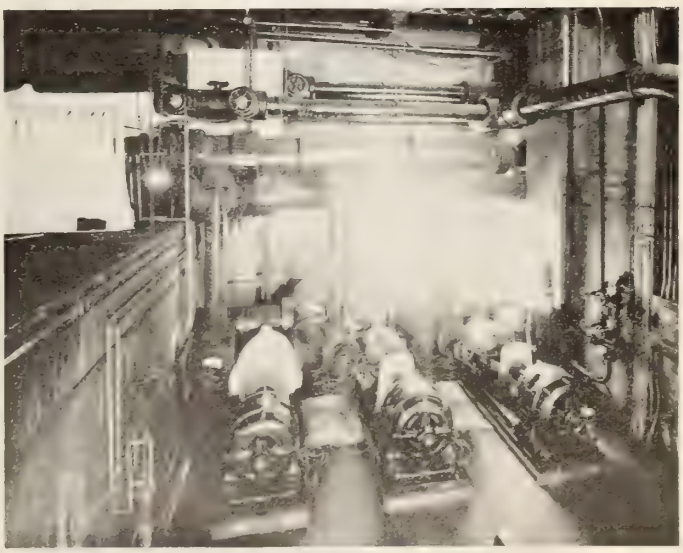


View of brine mains in basement.



Atmospheric ammonia condensers.

View of one of the cheese rooms.



View showing Ross-Roturbo brine circulating pumps.

erable amount of trouble with automatic sprinklers in low-temperature buildings, especially freezers, due to the condensation of the compressed air in the sprinkler piping, causing the stoppage of the pipes by ice. Major Sims gave this matter a special amount of study with the result that this new cold storage warehouse is equipped with a completely new system of automatic sprinklers on all floors subjected to temperatures below freezing point, operating by a solution of calcium chloride, the same as is being used for the cooling of the rooms. There are four overhead stor-

age tanks, situated in towers above the roof, each containing 15,000 Imperial gallons of calcium chloride solution. In the event of a fire occurring of such magnitude that this storage supply of 60,000 gallons of solution is not sufficient to deal with it successfully, the city water supply is automatically turned on to the sprinkler system, through the operation of two 8-inch automatic deluge valves. As, however, calcium chloride solution of the density to be used has an extinguishing effect of not less than 600 per cent. higher than that of water, it is the opinion that the fire which cannot be successfully extinguished by this large quantity of solution will be beyond the extinguishing power of the city supply.

Another great feature, and one which is also entirely new, is the special alarm system which has been installed throughout the building. This consists of little devices attached to the ceilings of the various cold rooms, which operate at a rate of rise of the temperature of the rooms, at or above fifteen degrees Fahrenheit per minute, and which operate a red signal light in the corridor adjacent to the room, also a loud fire gong in the centre of the corridor of that particular floor, and a fire gong and floor-indicator in the offices of the general superintendent, and in the power house. A sprinkler head operates at a temperature of about 165 deg. F. and in a room of, say, 10 deg. F. it would take about ten or eleven minutes for the head to operate with the rise at the rate of fifteen deg. per minute; whereas, with the special alarm system above described, the alarm is given almost instantly, even if the rise in the room is only one degree, so long as the rate of rise per minute is fifteen degrees, thus enabling the operators either in the warehouse or the power house to ascertain the locality of the fire, and effectively deal with it by means of the corridor hydrants, even before the automatic sprinklers may be required to operate. While on the subject of fire protection, it should be noted that all the elevator shafts, stair-shafts, and other possible means of creating a draught to assist a fire, are each provided with an automatically closing door, operated by this same device which works at a rate of rise in the surrounding temperatures of fifteen degrees or more per minute. In addition, the building is provided with one main fire-wall, absolutely dividing one half of the building from the other half, to prevent the spread of fire. All windows throughout the building, are provided with wired glass. The whole of the work entailed by this automatic sprinkler system and the special alarm system has been installed by the Automatic Sprinkler Company of Canada, Limited, of Montreal, with the exception of the overhead tanks which were furnished and erected by the Horton Steel Works, Limited, of Bridgeburg, Ontario.

Cold Room Insulation

The insulation of the cold rooms in a building of this nature is a very costly and a very important feature. Initially, only four floors are at present insulated, but the building has been designed for an extension of the insulation as the business warrants. This insulation consists of layers of compressed cork-board, which are laid against the walls and ceilings in cement, the aggregate thicknesses varying from 4 to 7 inches, according to the position of the rooms and temperatures to be maintained. This insulation contract was divided between two firms, The Armstrong Cork and Insulation Company, of Montreal, and the Canadian Corkboard of Port Colborne, Ontario, the total cost amounting to nearly $200,000,000. All the brine mains inside the warehouse, also those in the power house are covered with four inches of compressed cork, this work being done by the Armstrong Company at a further cost of nearly $70,000.00. It is not often understood how important it is in a plant of this character, to have the highest efficiency in regard to the insulation of the rooms and the brine mains.

MAJOR R. P. SIMS,
Montreal, Canada.
Constructing Engineer, under whose supervision the plant was constructed.

Elevator Installation

Provision has been made in the warehouse for eight electric freight elevators and one electric passenger elevator. At present, only four of the freight elevators have been installed, and also the passenger elevator, these being manufactured and erected by Darling Bros., Ltd., of Montreal. The freight elevators have a platform 9 ft. x 12 ft., and have a normal capacity of 12,000 lbs. when running at a speed of 90 ft. per minute. They are of the overhead, single-wrap traction type operated by a special high-torque 40 h. p. motor controlled by an automatic elevator controller with car-switch in the car. Each elevator is fitted with two powerful magnet-operated brakes, and also with hand-controlled wedges on the floors for securing electric or other trucks in position during travel of the car. The electric passenger elevator has a normal capacity of 2,000 lbs. when traveling at the rate of 200 ft per minute. The size of the platform is 5 ft. x 6 ft., and is also of the overhead traction type.

The whole of the cement used in these structures was supplied by the Canada Cement Company of Montreal, and the reinforcing steel was supplied by the Steel Company of Canada, the cost of this alone amounting to $180,000.00. The face brick was supplied by the Inter-provincial Brick Company and the terra cotta tile by the Montreal Terra Cotta Company.

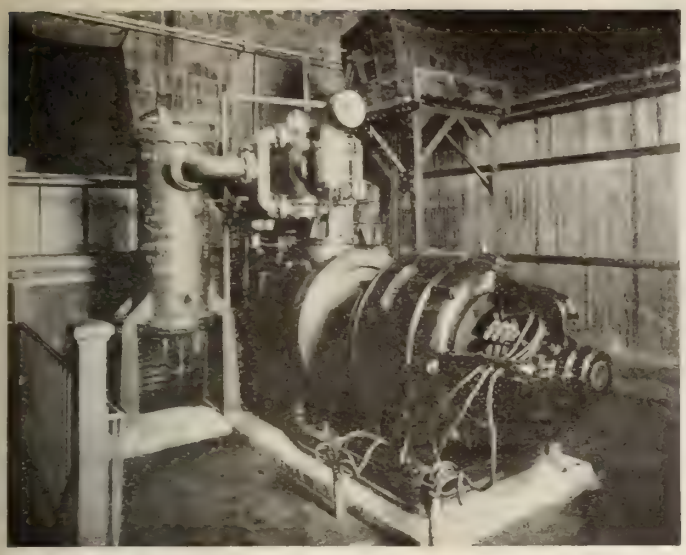
The buildings each stand on a concrete slab, supported by concrete piles inserted by the Canadian McArthur Concrete Pile Company. The soil on which these buildings stand is partly sand and partly clay, and the piles were driven through this until they reached hard pan or shale rock. The total number of piles driven amounted to 2,942, the total lineal feet being 55,551, the diameter of each pile being about 16½ in., and the load on each pile is about 60 tons.

One of the most important features of the cold storage plant is the arrangement by which ten standard refrigeration cars can be run end-on into the warehouse and closed in by Kinnear Rolling Steel Doors, so that the cars can be filled or emptied without any undue loss of refrigeration either in the goods or in the cars, and it also obviates the disadvantages due to cartage.

The Power House

The power house is situated east of the warehouse and is somewhat unique in design, on account of the lack of ground space due to the requirements of the harbor railroad tracks. At present, there are three horizontal, belt-driven, Linde ammonia compressors installed, each having a normal refrigerating capacity of about 150 tons per day. These compressors are each driven by an electric motor of 250 horse-power, two of the motors being made by the Canadian General Electric Company, and one by the Canadian Fairbanks Company, the latter being of ball-bearing type. A fourth ammonia compressor will be installed at a later date and provision has been made in the design of the power house to enable an additional two ammonia compressors of the same size to be installed, should the business of the warehouse warrant such extension. In the meantime, this space is being used as an electric sub-station, for transforming the alternating current received in bulk from the Montreal Light, Heat & Power Company into direct-current for use in connection with the traction requirements of the harbor railways, and it also contains all the switchboard equipment for the cold storage plant.

In each of the ammonia compressor rooms, and also in the electrical sub-



View of deep well air compressor.

Interior view of one of beef rooms.

station room, there has been installed an overhead traveling crane, each of a normal lifting capacity of 12½ tons. These cranes were of particular advantage during the erection of the machinery and will always be of use whenever it is necessary to carry out any repairs necessitating the lifting of any of the heavy parts of the equipment.

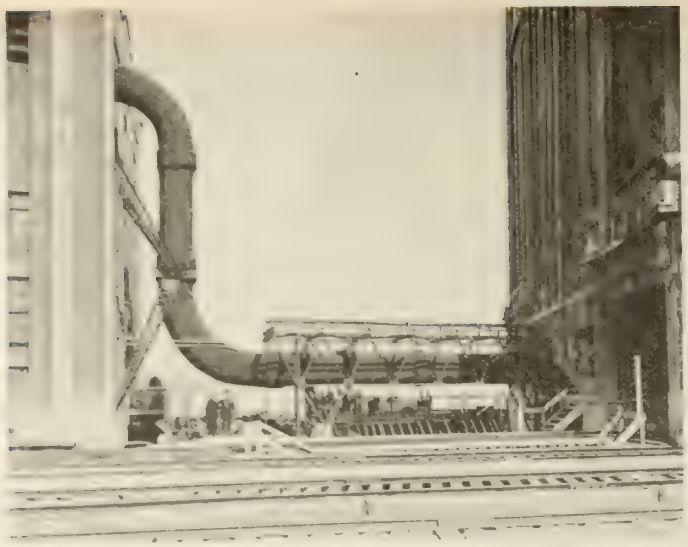
On the floor immediately above the ammonia compressors, there is a considerable amount of heavy equipment, chiefly in connection with the cooling and circulation of the calcium chloride solution used in the cold rooms of the warehouse. There are two large brine coolers, each consisting of a tank with 56 endless coils immersed in the solution. Each tank is about 36 feet long by 26 feet wide by 8 feet deep, and each coil consists of about 600 lineal feet of 1½ in. wrought-iron lap-welded pipe in one continuous length. The brine cooler tanks were fabricated and erected by the Dominion Bridge Company of Lachine, each tank weighing alone about 60 tons. The endless ammonia expansion coils were made by Mr. James Ballantyne of Montreal, all welding being done by the Thermit Process, and every coil being hydraulically tested to 650 lbs. per sq. in. The insulation of these large brine coolers is very heavy due to the very low temperature of the solution contained therein, this work having been done by the Armstrong Cork & Insulation Company. The cooling of the solution is accomplished by the expansion of liquid-ammonia into ammonia-gas inside the coils, and this ammonia-gas is then drawn out of the coils by the ammonia compressors, and thence delivered to the ammonia condensers. These brine coolers each contain approximately 210 tons of solution, which can be used as a reservoir for cooling the rooms in the warehouse for several hours, even if the compressors are stopped.

On this floor, also, there are at present installed four electrically-driven brine-circulating pumps, with provision for two more to be installed at a later date. Each of these pumps is capable of delivering 600 imperial gallons of calcium chloride solution to the warehouse per minute; they are of the Rees-Roturbo type, made by Goldie & McCulloch of Galt, and supplied by Ross & Greig of Montreal, the motors being made by the Canadian Westinghouse Company. This solution, immediately it leaves the pumps, passes through a Venturi meter, which indicates, registers and records the amount of flow. In addition, there has been installed a Bristol recording and indicating equipment by Peacock Brothers of Montreal, which continuously indicates and records the temperature of the solution as it leaves the power house, and also as it returns. These records of flow and temperature of the solution are of great assistance to the operating engineers, to enable them to detect, at a glance, any variation in the efficiency or operation of the plant.

On the brine-cooling floor also is an electrically-driven, high-speed, vertical air compressor, made by the Browett-Lindley Company of England and sup-

View showing 56 ammonia expansion valves.

View showing typical distributing corridor.



Brine mains from power house to warehouse.

[illegible] by Peacock Brothers, the motor being manufactured by the Canadian Westinghouse Company. This air compressor is used for the lifting of the water from the deep well outside the power house, and has a capacity of 350 cubic feet per minute, with a pressure of 125 lbs. per sq. inch when running at 390 revolutions per minute.

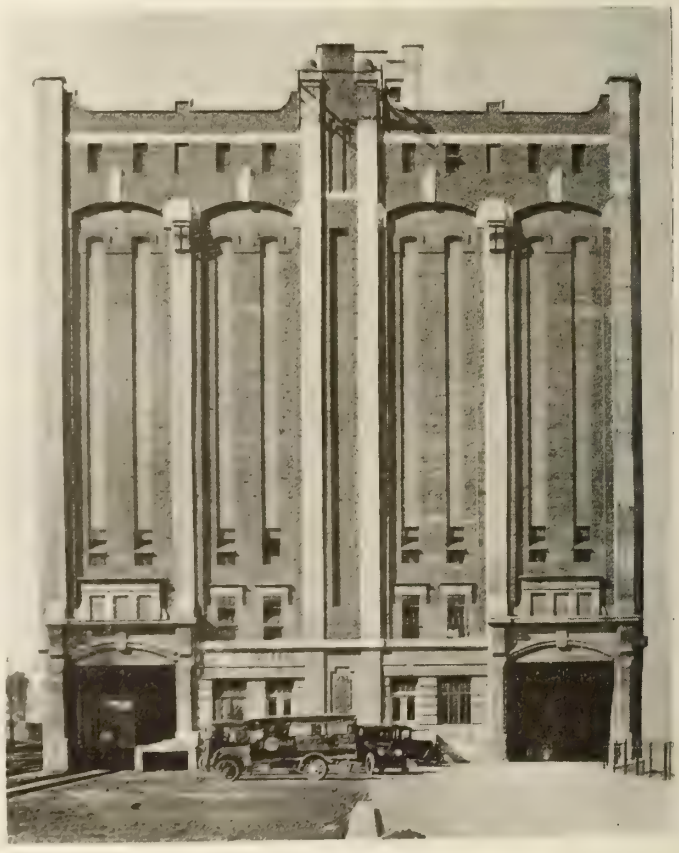
There is also on this floor a small ice-making tank, which is capable of making 5 tons of ice per day, in 100 lb. blocks. This ice will be used in connection with the tugs, stores, etc., run and operated by the harbor authorities.

On the roof of the power house, but surmounted by a double-deck cupola, are situated the ammonia condensers. These are of the atmospheric type, each of about 150 tons normal refrigerating capacity, of which there are three at present installed, with provision for an additional unit in the future. As the name implies, these condensers are for the purpose of condensing ammonia-gas into liquid ammonia. As previously described, the ammonia-gas in the expansion coils in the brine coolers is drawn out by the ammonia compressors, and is delivered under pressure into the coils of the ammonia condensers. Over these coils there is a continuous flow of cold water from the deep well, and it is the combined action of the pressure of the gas with the cooling effect of the water which causes the ammonia-gas to liquefy. As this gas liquefies, it runs by gravity into steel containers which act as reservoirs for the supply to the expansion coils in the brine coolers.

On a floor in the cupola, above the ammonia condensers, are situated two long water tanks for the distribution of the water for the condensers, and for other water supplies throughout the power house. These tanks are each 82 feet long, with a capacity of 21,500 gallons, and the water level will be automatically maintained by a supply from the deep well. These tanks were fabricated and erected by the Dominion Bridge Company.

The deep well is just outside the east end of the power house, it being 10 inches diameter by 1,100 feet deep. The water from this well will be pumped into a small separating tank in the basement of the power house by means of compressed air. The separator tank contains a series of weirs, which spread out the water in such a way as to separate the air from the water before it is pumped up to the two long distributing tanks over the ammonia condensers. Arrangements have been made for an adequate supply of water from the city mains to the distributing tanks, in the event of a failure of the deep well supply through temporary or other causes. The great advantage of the deep well supply for mechanical refrigeration is the difference in the average temperature of the water in the city mains, especially in the hot season of the year when the plant is working to its highest capacity. This difference of temperature of the water used on the ammonia condensers makes a corresponding difference in the pressure to which the ammonia-gas has to be compressed, resulting in lower power costs at the motors. This well was bored by the Wallace-Bell Company of Montreal and the pump was made by the Weber Pump Company of New York, and supplied and installed by the Garth Company of Montreal.

Almost all of the ammonia fittings in connection with this large plant were manufactured in Canada by the Crane Company, Limited, of Montreal. This company also manufactured and supplied a very considerable amount of pipe-work, mains, etc. The solution of calcium chloride, previous to its delivery into the brine coolers, is mixed by means of a specially-designed, electrically-driven brine mixer, furnished by the A. R. Williams Machinery & Supply Company of Montreal. In order for one to obtain an idea of the magnitude of this plant it should be noted that, for the initial charging up of the brine coolers, circulating coils and sprinkler system, it has necessitated the use of over 300 tons of granulated calcium chloride, all of which has been converted



View showing west end of warehouse.

General view of Montreal Harbor—showing Victoria dock and cold storage warehouse.

into a solution by means of this small electrically-driven brine mixer.

The whole of the reciprocating and rotary equipment of the power house has been installed with a gravity-feed oiling system made by the Richardson-Phoenix Company, of Milwaukee, and furnished by the A. R. Williams Machinery and Supply Company. By this equipment all bearings and other lubricated parts are furnished with a continuous supply of oil by gravity from a reservoir in the cupola over the power house, and after passing through the bearings this oil is automatically collected and passed through a filter in the basement, thus removing all foreign matter; it is then electrically-pumped back to the reservoir in the cupola, thus using the oil over and over again. Of course, there are certain losses in connection with this oil and it is bound to lose its effectiveness after a time; provision is therefore made for replenishing the reservoir, whenever necessary, with new oil.

All Canadian and British Work

It has been the desire of the harbor commissioners to make this cold storage plant not only one of great usefulness to the port and to the Dominion as a whole, but also to insure the design of the building to be one of credit to the harbor. The whole of the construction work in connection with the two buildings constituting the plant was carried out by the engineering department of the harbor; a work of considerable magnitude, and one to be justly proud of.

Exceptional care and thought has been exercised in the preparation of the plans and specifications of this cold storage plant in order that it shall be as perfect as modern engineering science and experience will permit. It has been the desire of the harbor commissioners and of the consulting refrigerating engineer that all material used on this great national undertaking should be strictly of Canadian manufacture, as far as it was possible and subject to the efficiency and cost of the plant not being impaired thereby. It is a source of much gratification that this desire has been carried out, and furthermore, the work of designing and constructing the plant and its equipment has been entirely undertaken in such a satisfactory manner by Canadian and British engineers and workmen. Major Sims was fortunate in having a very loyal and able engineering staff, and particular mention should be made of Mr. J. R. Dalkin, his direct representative on the work, also Mr. J. J. Dillon, who was in charge of the erection of the mechanical equipment, and Mr. F. J. DiBenga, the chief draughtsman on the work. Being of such a national character, owned by the people of Canada, there is no reason why the control and operation cannot be permanently and entirely in the hands of Canadians.

ENGINEERS AND THE POWER EXPOSITION

The National Exposition of Power and Mechanical Engineering to be held at the Grand Central Palace in New York from Thursday, December 7 to December 13, closing, however, on the intervening Sunday, is being planned in co-operation with the national societies interested in the economy of fuel and in the production and use of power generated therefrom.

The opening of the Exposition in the Grand Central Palace will take place on the closing day of the annual meeting of the American Society of Mechanical Engineers, and time has been set aside in the A. S. M. E. program so that members desiring may attend the opening exercises. Furthermore, the programs of the twenty sessions to be held at the meeting may reap the advantage of the technical discussions, and with the smallest possible expenditure of time, enjoy the novel and varied exhibits at the Exposition. A few of the subjects to be discussed at the A. S. M. E. meeting are:

Commercial Economy of High Pressure and High Superheats.
Feedwater Heating for High Thermal Efficiency.
Development and Use of Stokers.
Transmission of Superheated Steam.
Ash Removal—A Symposium of Modern Handling Methods.
Gears.
Power Required for Removing Metal.
Safety Valves.
Torsion of Crankshafts.
Pulsating Flow in Flow Meters.
Dry Vacuum Pump Tests.
Design of Flywheels.
Tests on Orifice Coefficients.
A Modern Works for the Production of Monel Metal Steam Table Research.

In addition, the A. S. M. E. Professional Divisions on Aeronautics, Ordnance, and Forest Products will hold sessions of general interest to the engineering profession.

The American Society of Refrigerating Engineers is to hold its meeting at the Hotel Astor for three days commencing December 5, and its members, as well as the members of the A. S. M. E., will be admitted to the Exposition upon the presentation of their membership cards.

The opportunity this Exposition offers for the power house operating man will also be grasped. The National Association of Stationary Engineers is perfecting plans for the various chapters to visit the Exposition in a body. In addition, the New York Building Superintendent's Association, 600 strong, will attend in a body and they will be received by the officers of the N. A. S. E.

The list of exhibitors already assures the fact that the Grand Central Palace, with its remarkable facilities, will house the greatest exhibition of power plant equipment ever contemplated.

(Continued on page 35)

Large Variety in Appliances Available

The Manufacturer Has Placed at the Service of the Engineer a Large Number of Excellent Devices. The Engineer Should Be Familiar With Them, and Able to Advise Intelligently on Their Use

By T. H. FENNER

WHILE there are a certain number of industries which find it possible to obtain all their power from central power stations, either government owned hydro electric, private hydro electric, or steam generated, there are practically none that do not use steam in some part of their work. It may be that it is only for heating the building, or the office, in the cold weather, but it has to be there. The generation of steam implies a boiler, and the presence of a boiler necessitates auxiliary equipment, even if that be only a small injector. With this as the elementary form of steam using industry, we progress all the way to the factory which uses steam as a power generator, steam in process work, and steam for heating. The steam for heating may be a by-product of the steam used for power, and the process steam may also, to some extent, be of the same nature. In the range of the passage of the steam from boiler to engine, through the exhaust piping, and other steam piping, back to condensate which may or may not be returned to the boiler, there is a great variety of equipment installed. It is somewhat of a problem for the factory executive to know where the use of appliances changes from a necessity to a luxury, and it is on this point that the engineer in charge of the plant should be able to give him correct advice. If the installation is a new one, it is probable that all the equipment will have been specified by the consulting engineer, but there are many plants which start their existence on the scale of the elementary boiler plant we have already mentioned, and gradually grow up to the highly complicated form just alluded to. Sometimes the engineer who saw the inception of the plant grows with it, in every sense of the word, but there are other cases where the original incumbent of the position becomes overawed with the extent of the growth and retires. We have seen a number of instances of both conditions.

Elementary Plant Has Problems

In the very small plant consisting merely of a boiler and a means to feed it, a problem often arises which is a puzzle to the owner, and often to the boiler attendant. Shall he use a pump for feeding, or shall he use an injector? Well, what are the advantages and disadvantages of each piece of apparatus, and what is the situation in regard to the feed water? Can the condensate be used again for feed water, or has the feed to be made from fresh water entirely? Is the boiler driving an engine, or is the steam used entirely for heating? Perhaps the steam is being used merely for heating hot water, in which case it is discharged directly into the tank to be heated.

If the feed water has to be entirely fresh water and no condensate is available for feed and there is no engine exhaust available for heating, then an injector represents the best method of feeding on the small boiler up to 50 horse power. It is compact, has no moving parts, and has the great advantage that there is practically no loss of heat incurred in the act of getting water into the boiler. The heat of the steam used to operate the injector is all returned with the feed water. It is positive in its action when handling cool water, and has practically nothing to get out of order. It can be operated with low steam pressures.

If, on the other hand, exhaust steam is available for heating the feed water, or the condensate can be returned to a hot well from which it can be pumped at fairly high temperature, or if a receiver can be used which can be placed above the suction of a pump, then a pump becomes a better means of feeding than the injector. Of course, when large sizes of boilers are being used, an injector is out of the running as the size required would make it cumbersome, and furthermore, it has not got the flexibility of the pump. If the boiler is used for purely heating purposes, then the best arrangement is either feeding by means of gravity return traps, or a vacuum return system and a pump and heater, in which the exhaust from the feed pump can be used to raise the temperature of the condensate from 150 to 180 or 200 degrees. In the case of the pump handling returns through a receiver, there is the disadvantage that in many cases the condensate is cooled by the admission of cold water from the city service mains, and this is resorted to also in the case of the vacuum pump in vacuum return systems. In the case of the vacuum return system the other advantages outweigh the small amount of heat lost by the use of the small condenser on the pump. When gravity return traps of the tilting type can be used they represent the ideal way of boiler feeding, as they combine the advantages of the pump with that of the injector. The drawback to most of the tilting traps is the double caused by the packing of the trunnions, which requires considerable care and maintenance if the trap is to function properly.

It can thus be seen that even in the small boiler room there is scope for the use of engineering common sense in deciding on the type of equipment which shall be installed.

Hand Or Mechanical Stoking

The question of whether the boilers shall be equipped with mechanical stokers or shall be hand fired is one that largely depends on the size of plant. If a plant has only one boiler then it is certain that there can be no saving of labor by the installation of mechanical stokers, as an attendant will be required in any case. In the small boiler plant it is possible to instal one of the many excellent hand-operated dumping or moving grates, and while these do not eliminate the fireman they certainly tend to greater fuel economy. By relieving the fireman of the necessity of cleaning fires they make his work much easier and enable him to devote some of his time to keeping the boiler room in better shape. Cleaning fires is a task that puts a terrific strain on the human frame and takes more out of a man than several hours of ordinary firing would do. Where only one man is employed, as is so often the case, installing a hand-operated stoker is worth while even if the economy effected is of the slightest. The investment is itself only slight, and will pay dividends in the shape of a more contented fireman and a better kept boiler room.

When the larger plant is in question the installation of mechanical stokers should be considered from several viewpoints. First there is the return in the investment due to saving in labor; second, the saving by being enabled to use a lower grade of fuel; third, the saving due to better combustion and general efficiency, and in some cases saving in first cost by the possibility of installing a smaller boiler plant. This last is, of course, due to the mechanical stoker being capable of carrying heavy overratings for short periods, such as peak loads in a central station. Many manufacturing plants are also subject to heavy peak loads of an hour or two duration, notably in those cases where the full lighting load on dark days comes at the same time that the cupola is put into service for making the daily cast. In general, it may be said that in any plant of 500 horse power or over, the mechanical stoker is justified.

Coal and Ash Handling

The method of storing coal, the capacity of the bunker immediately adjacent to the boilers, the capacity of general storage, the location of the general

storage in relation to the service bunker, and the receiving period will all be factors in determining the necessity of coal-handling apparatus in the first place, and the type of machinery in the second place. Many small plants are so situated that the maximum reserve that can be carried is only equal to three or four days' supply, and the consumption is so small that one man can very easily attend to the delivery of coal to the boilers and the removal of ashes. If such a plant is below the street level the coal can be usually dumped direct from a cart into a bunker immediately communicating with the boiler room, and there is no problem in the receiving of coal. The removal of ashes from the ashpit and in the case of h-r-t boilers of the deposit from the combustion chambers may constitute a necessity for some type of conveyor. This can in most cases be met by the installation of a simple I beam with a travelling hoist either electrically or pneumatically operated, or fitted with a differential chain block. By this means the buckets can be raised from boiler floor level to the street level, or high enough above it to allow dumping into a wagon, with the attention of the same man who handles the coal. This type of equipment is cheap to instal, and costs practically nothing for upkeep.

In cases where there are several boilers and hand-firing is used, the same type of trolley carried right along the boiler fronts at a convenient distance from the front for the firemen and with switches communicating with the bunker will enable one man to keep the firing floor well supplied and also look after the ashes. The ordinary method of handling coal from bunker to firing floor with a barrow is, except in the case of extremely small plants, a wasteful one in both labor and coal. The amount of coal that is spilled from wheel barrows and ground up on the floor of bunker and boiler room amounts in the course of a year to a very appreciable total.

When considerations of space make it necessary for an overhead bunker to be installed, then of course coal handling apparatus becomes compulsory. This will usually be of the bucket or flight conveyor type and will usually be arranged in such a manner that the hopper cars, if the plant has a railway siding serving it, or the coal wagons, can dump their contents into the hopper of a coal crusher, the crushed coal being delivered into the bucket conveyor, and thence elevated to the overhead bunker. By partitioning off one end of the overhead coal bunker a receptacle for ashes can be made which communicates by means of a shute with the railway siding or yard. The ashpits of the boilers are arranged to slope down to a tunnel in which the lower flight of the conveyor runs. The same conveyor thus serves for both ash and coal handling.

If, by reason of getting all coal in during two or three months of the year, more favorable prices can be obtained, and there is space for yard storage, some means of unloading cars and piling the coal must be installed. Provision must also be made to reclaim coal from yard storage to bunker. For this purpose either a locomotive crane, overhead trolley carrying a grab bucket, or portable conveyors can be used. If tracks are already laid in the yard, an electric or steam locomotive crane can be usefully employed. The overhead trolley system is good if the coal can always be stored in the same position and a straight way communication with the boiler room can be obtained. For the general run of yard storage in medium sized plants the portable conveyor offers the best solution, as it can be moved around to suit conditions independent of tracks or overhead construction.

Where the amount of coal to be handled on the firing floor is over two tons per hour, it will, in general, be economical to instal mechanical means of coal handling. The amount of ashes to be handled will usually run from one-tenth to one-fifth of the amount of coal fired. It may be necessary to arrange separate ash handling machinery so that the continuous operation of the coal conveyor will not be interfered with, and a number of plants are now using the vacuum or steam jet ash conveyor for this purpose.

For handling coal over long distances such as from a ship at the wharf to yard storage, a combination of belt conveyor and drag bucket may be used to good advantage. The belt conveyor can be used over considerable distances and at fairly high speeds, and the ordinary run of coal is not particularly abrasive. It can be arranged on a rising incline from wharf to storage, and a drag bucket on a trolley arranged at right angles to the shore end of the belt conveyor can be used to spread the coal out in a flat pile.

There are different conditions to be allowed for in every plant, and the purpose of this article is merely to indicate the different types of apparatus that are available, and some of the general considerations governing their use.

The use of coal handling equipment has another advantage in that it is possible to incorporate accurate weighing devices with the machinery and thus keep a reliable check on the coal being burned. In the case of the overhead bunker arrangement, the coal is delivered from the bunker to a travelling weigh larry which automatically weighs the coal as it is delivered to the stoker hoppers, printing a weight ticket in the same manner as the ordinary track scales do. If there is no overhead bunker, a weighing device can be placed at any convenient place between the receiving and delivering end of the coal conveyor. In the estimating of coal consumption by space measurement or checking the number of barrow loads or trucks wheeled into the boiler room serious discrepancies can often arise, and we know of a case where bunker storage of about 2,000 tons was carried and during the course of five years a discrepancy of about 1,500 tons between the coal received and coal accounted for was discovered. This would probably never have come to light except for the fact that a coal shortage occurred and, for the first time in years, the storage was cleaned out. This was perhaps an extreme case, but it illustrates the possibility of error due to wilful manipulation of records or carelessness.

Tube Blowing

There should be no question in any plant, large or small, as to the benefit to be gained by using mechanical soot blowers. The old method of trying to keep the surfaces of the tubes clean by hand lance is wasteful of steam and poor in results. It is a difficult and to some extent dangerous job, and there is not one man in one thousand who will conscientiously carry it out. The rubber hose used for the lance is constantly giving out, and is expensive to replace.

The installation of a mechanical soot blower, a type of apparatus which has been brought to a high state of perfection in recent years, ensures a thoroughly satisfactory means of keeping tube surfaces in the best condition with no more effort than is required to open a small valve. The use of specially prepared metals and improvements in design has eliminated the early trouble caused by burning out, and other improvements have materially reduced the steam consumption. The upkeep is small, and the return on the investment high. So successful has this particular piece of equipment been on land that it is being introduced quite considerably into marine practice, and with equally good results. Dirty tubes on long runs used to be a source of trouble in marine work, as well as much loss of fuel. Marine engineers should be grateful for the advent of the mechanical soot blower. In the case of economizers, the steam soot blower is, in many cases, taking the place of the chain scraper with which all economizers were at one time fitted.

Boiler Room Instruments

There are a large variety of recording and indicating instruments now available for the boiler room, each of which can give invaluable service if rightly applied and intelligently used. It is lamentable but true that there are still many factory managers, and factory engineers for that matter, who are under the impression that hanging some particular instrument on the wall of the engine or boiler room will immediately result in fuel saving. Naturally, when this does not occur, the instrument and all its kind are roundly condemned. When a physician places his stethoscope on the chest of a patient he does so because the stethoscope will give him an indication of what is going on within, and not for any healing properties possessed by the instrument. It is exactly the same with the instruments used in the boiler room. They possess no mag-

ideal properties of themselves, but they do indicate how far away from, or how close to the ideal operation the plant is. It is then up to the intelligence of the man in charge to diagnose the case and apply the remedies for the particular troubles indicated.

One of the first considerations governing the installation of instruments then should be the possibility of them getting fair care and attention. That being guaranteed or assured to a reasonable extent, the next factor will be what return they are likely to give on the money invested. Obviously there could be no advantage in placing an instrument costing two or three hundred dollars into a plant which had but one boiler and one man to attend to it. While it is quite possible that a salesman might show where the investment could be justified, it is doubtful if in practice it would work out. There are, of course, cases where the instrument is necessary apart from any return it may make, such as a steam recording gauge where a fire pump and sprinkler system are installed. This gauge is just as necessary as the steam gauge on the boiler, and cannot be looked at from the economical point of view at all.

The principal instruments available to the engineer today are the recording instruments such as recording thermometers, recording steam gauges, draught gauges, CO2 recorders, recording meters for steam, water or air. It is not every plant that can afford or needs a full installation of all these instruments, but there is no plant so small that they cannot afford one of them. We leave out, of course, the extremely small plant up to 50 horse power, and those plants whose fuel is the refuse from a manufacturing process and therefore has no cost. We would say that practically every plant should have a draught gauge, even if it is merely a bent tube with a 6-inch scale attached. With this simple instrument a fireman can find by experiment just what particular condition of draught gives him the most satisfactory results, and can detect leaks in the setting of his boiler.

There are a number of very good draught gauges on the market which are inexpensive and can be fitted directly on the boiler front. These are especially useful in the plant of more than one boiler, as they form a guide to the setting of the dampers on the individual boilers, as well as the main damper. Slightly more elaborate than the differential draught gauge are those which not only indicate conditions of draught but have corresponding directions for correcting wrong conditions. For instance, a direct reading instrument can be obtained which shows at a glance the flow of air in its relation to the flow of steam, and the flue gas temperature at the same time. This type of instrument is very valuable where a fireman is working without supervision, because it gives him a ready indication as easily read as his steam gauge as to whether conditions are correct or otherwise.

CO2 instruments can be obtained either giving a record on a chart or a constant direct indication, or both. There are a number of these instruments by different makers on the market. While the permanent record is an excellent thing for checking up results and discovering wrong conditions, there is no question of the value of a direct indicator right before the fireman, be the plant large or small. In the large plant it gives the individual boiler attendant a means of checking up his operation every moment, while the accompanying recorder gives the operating head the story of the day's doings in relation to all his other records.

Recording thermometers are a very useful type of instrument and can be applied to a number of different purposes. Where a feed heater is installed a recording thermometer should also be installed to show that the heater is being operated in such a way as to always get the benefit of it. Careless operation of a feed heater can largely neutralize its usefulness and a permanent record of the temperature over the twenty-four hours gives a very effective means of keeping tab on the operators as well as showing the economy effected. A recording thermometer, showing flue and gas temperatures, if used in conjunction with a draft gauge, forms a useful pilot for operating conditions where no other instruments are available. It also shows when heating surfaces are becoming dirty, for a steady rise of flue gas temperature, with firing conditions remaining the same, is a sure indication that the heat is not being absorbed. Where it is important that rooms be kept at a steady temperature, such as kilns, or drying ovens, the recording thermometer is the only means of ascertaining whether this has been carried out or not.

Meters such as the Venturi or V notch weir type, placed on the boiler feed line, give an accurate record of the amount of water evaporated. This checked against the amount of coal fired gives a direct indication of whether the fuel is being efficiently used or not. It, of course, does not tell in what way the loss, if any, is occurring, but it inevitably points out that there is a loss. If the amount of water delivered to the boiler and the temperature at which it is delivered and the quantity of coal burnt is known, there is a direct check on the efficiency being obtained.

Steam flow meters take up the story where the feed water meter leaves off. These meters may be attached to the main steam pipe of a boiler, or the main header of a battery of boilers, and show how much steam is being delivered from each boiler, or from them all. If the amount of steam delivered is less than the amount of water delivered, then there is a leak taking place, or perhaps a number of small leaks. The meter can be attached to a branch pipe leading to a particular department, and the amount of steam used by that department accurately checked. Further, if a battery of boilers in operation is fitted with a steam meter on the steam pipe of each boiler, the share of the total work being done by each can be seen at once. This is a particularly useful feature of the steam flow meter, because it often occurs that one boiler in a battery is doing considerably more work than another, the one being worked at high efficiency and the other at low efficiency.

In a large plant where the consumption of fuel is considerable, and the power costs form a considerable item of the manufacturing cost, or in a large central station where power costs are practically the whole manufacturing costs, the fitting of suitable instruments enables a check to be kept on the conversion of the fuel heat into power at every step, from the coal car to the condenser discharge.

The coal is weighed on a track scale before it is dumped from the car to the coal handling equipment, and every pound is automatically weighed as it is delivered to the boilers. The intensity of draught, the pounds of air per pound of fuel, the flue gas temperature, the feed water temperatures at entrance to heater, discharge from heater, entrance and discharge of economizers where fitted, are all recorded. The amount of feed water delivered to the boiler, the amount of steam discharged from the main steam pipes, the temperature of the steam when superheated, the temperature of the exhaust leaving the engine or turbine, the temperature of the circulating water leaving and entering the condenser, are all available in the records. The amount of ash carried out is also recorded. In this way it is possible to strike a balance sheet, which shows on one side the amount of heat delivered to the plant as fuel, and on the other, item by item, the amount of heat turned into useful work, and the amount of heat which is inevitably lost. The purpose of all the instruments employed is to keep this loss down to the smallest possible amount, and the intelligent comparison of all the different records obtained show the operating staff exactly where the losses are taking place.

In distinction to this elaborate checking up which represents the highest practice, there is the check already mentioned which is the amount of water evaporated and the amount of coal burnt. If coal of 11,000 B.t.u. per pound is being burned, and the boiler is working at 100 pounds per sq. in. pressure, and the feed is at 100 deg. entering the boiler, then there should be an evaporation of approximately 7 lbs. of water per lb. of coal, which is an efficiency of about 70 per cent. If the evaporation is only 5 lbs. then there is clearly something wrong.

If we reckon 70 per cent. efficiency as a fair efficiency to be aimed at, that means that each ton of coal is only delivering about 70 per cent. of its pos-

(Continued on page 33)

Power Can be Obtained From Refuse

The Gas Producer Has Been Steadily Improved During Recent Years, and Provides an Efficient Means of Turning Certain Manufacturing Wastes to Beneficent Uses

By F. JOHNSTONE-TAYLOR

IT IS always adequately appreciated that small power plants can often be very economically operated by burning combustible refuse in a gas producer. In new countries, especially where wood fuel is more or less plentiful, and coal both scarce and dear, does this system of power production present special advantages. The burning of wood and similar soft fuel in boilers is a wasteful procedure at the best, the boiler furnaces have to be specially constructed, and except for quite small plants in which economical operation is unnecessary, it cannot be said to provide a satisfactory solution of the power problem. Again the steam engine in small sizes is not by any means an efficient unit, although admittedly there is much to be said for engines of the locomotive type which are specially constructed for the economical operation of small steam plants. The gas engine on the other hand has so many proven advantages for this purpose that it is unnecessary to dilate upon them here. It is not, however, so generally appreciated that the suction gas producer, so well known in connection with the use of anthracite, has been considerably improved of recent years in connection with burning wood refuse and other waste products. It is now quite an established method of power production, and one which as stated, must when fully appreciated, appeal especially to power users, and prospective power users in new countries. While wood refuse is obviously the most suitable substitute for coal, besides being likely to be the most plentiful, certain industries provide a considerable quantity of other combustible refuse, which can usually be turned to equally good account. In what is to follow, therefore, although primarily the waste wood product is referred to it should be understood that it can usually after putting the whole facts before the makers, be installed for operation on most forms of dry combustible matter. Such products as sawdust, spent tan, peat, waste, cotton seed, coffee and cocoa husks, mealie cobs, cocoanut shells, sugar cane refuse, etc., are all suitable for the purpose and the mere fact that when not so used they accumulate in such quantities as to often cause positive annoyance should be sufficient to turn the power user's attention to them as a source of possible power and consequently profit.

The Suction Producer

The principle on which the suction gas producer works is exceedingly simple. Air and steam are passed through red hot fuel and converted into inflammable gases which are used for power purposes. The mixture of air and steam is sucked by an ordinary gas engine through the furnace in the gas generator, then through "scrubbers" or cleaners where all the dust or volatile matter from the fuel such as tar is washed out with water, and then into the engine. What really happens in the generator is this:—

When air passes through red hot fuel, combustion takes place and carbon dioxide gas (CO_2) is formed. This gas is the product of complete combustion and will not burn. However, as the CO_2 continues its way through the fire it absorbs more carbon and becomes CO or carbon monoxide gas. This gas is combustible and is one of the gases that go to make up the composition of suction gas. When steam is passed through red hot fuel it is split up into two gases both of which are combustible, H or hydrogen, and CO. The nitrogen in the air N passes through the generator unchanged and is mixed with the suction gas. In practice traces of other gases such as marsh gas CH_4 are found but these depend on the kind of fuel used. Under average working conditions the composition of suction gas would be about CO_2 7.2 per cent., CO 18.6 per cent., CH_4 1.6 per cent., H 17.6 per cent., N 54.4 per cent., O .6 per cent. and the calorific value would be about 140 B. t. u. per cubic foot.

From the above a rough idea can be formed of what takes place in the generator and of the composition of the gas formed but it is quite unnecessary for the attendant to know anything about these details as the whole process is perfectly automatic.

A suction-gas plant may be divided into three parts.

1. The generator in which the gas is formed.
2. The scrubbers in which the gas is thoroughly washed to remove dust and tar, etc.
3. The gas engine in which the gas is consumed and the power developed.

The Generator

Suction gas generators are made chiefly in two types; the up-draft and the down-draft. In the former air and steam are sucked upwards through the fuel and in the latter downwards. The up-draft generator, however, is almost universally used as it gives the most economical results; the down-draft type has been developed chiefly with the idea of burning soft or bituminous fuel containing a high percentage of tar or oil, the vapours of which, when driven off by the heat of the furnace, are drawn down through the red-hot fuel where they are split up into fixed gases which help enrich the gas, whereas with the up-draft generator they would either be washed out in the scrubbers and lost or would pass on and clog up the engine. With down-draft generators it is also much easier to renew the fuel and clean out the furnace

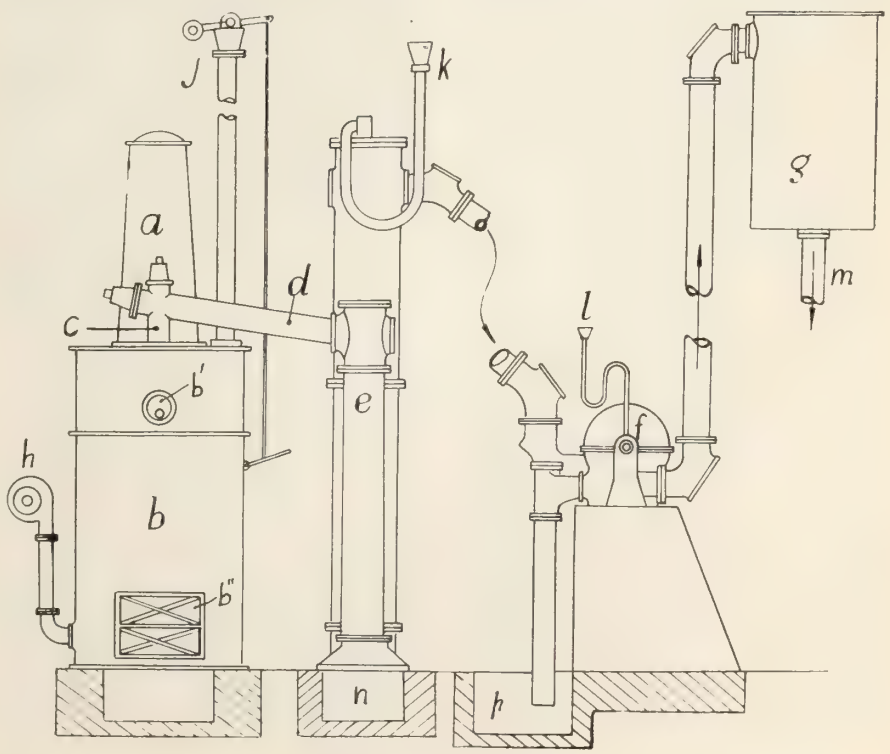


Diagram of Gas Producer.

without unduly diluting the gas with air.

Cleaning And Cooling The Gas

It was previously mentioned that a supply of steam was essential to the operation of a suction producer. Most refuse of the kind under discussion contains the necessary moisture and arrangements for supplying it are usually absent. A very important part of the apparatus, however, is the "scrubber." Scrubbers serve two purposes; to cool the gas and to clean it before it can be used in the engine. The gas leaves the generator at a very high temperature; as the volume of a gas varies with its temperature it is necessary to cool it as much as possible in order that the engine may get a full charge. Another objection to gas entering the cylinder at a high temperature is that it may cause back firing. The gas also carries with it considerable foreign matter from the furnace which would set up wear on the piston and cylinder of the engine if admitted; this is also removed in the scrubbers. The scrubber usually consist of a closed vessel in which the gas enters at the bottom and rises up against a water spray, the interior of the vessel being so arranged that the streams of gas and water are very intimately mixed. A coke scrubber is installed principally for cooling. This consists of a cylindrical iron vessel with a perforated plate a few inches from the bottom. This supports a bed of ordinary coke which reaches to within a short distance of the top of the scrubber. The pieces of coke vary in size frm 1½ inches to 2½ inches, the larger sizes being at the bottom and the smaller at the top. Above the coke is a perforated pipe or tray for distributing the water evenly over the whole area of the scrubber. The gas enters at the bottom of the scrubber and leaves at the top and in passing between the pieces of coke is broken up into very attenuated streams flowing in the opposite direction. After passing through the scrubber, which in some plants is called a dust extractor, it is usual for the gas to be treated by a tar extractor, usually of the centrifugal or rotary type, and it then finally passes through a dry scrubber which is generally a box filled with sawdust, or similar material, the actual details differing, of course, with the individual design.

The Various Types

There are several well known types of waste wood gas producer made in England, the Ruston, Crossley, and National being representative of their class. They are all adaptable to burning other forms of combustible refuse as well as wood. The general arrangement shown in Fig. 1 is that of the Ruston. Referring to the lettering on the diagram the fuel chamber is of large capacity, which is necessary to avoid too frequent charging. Before reaching the combustion zone of the generator, the fuel passes down through a distilling chamber, where, subjected to the heat of the surrounding gas it gives off volatile constituents which enrich the gas.

The generator b is constructed of thick steel plates lined with firebricks and packing, doors b2 being provided in the casing for the purpose of cleaning the fire. The firegrate consists of loose firebars which can be removed and replaced through the firedoors. It is not usual for a hopper with slide or valve to be provided for wood fuel, this being fed directly into the fuel chamber. Poking holes b1 are arranged so that any part of the furnace can be reached and the fire consolidated. Instead of leaving the generator by the usual single outlet the gas is taken off at two or more points on the top thereof by the vertical pipes c which lead into the main pipes d sloping down towards the dust collector e. The latter constitutes the scrubber. The outlets are arranged so that an even draft is ensured through the fuel bed at all points and under all conditions of load. The outlet pipes d are provided with scrapers by which tar and dust deposit can be removed at any time without interfering with production. From the top of the dust collector e the gas passes to a two stage rotary tar extractor f where the tar is thrown out before the gas passes into the sawdust scrubber. From 6 to 8 gallons of water per B. H. P. hour are required for cooling and cleaning the gas. Most of this water can be used over and over again by installing a filter, sump, and circulating pump, about 1 gallon per B.H. P. hour of clean water being required as "make up." In common with some of the other makes this producer can be used with anthracite or coke if fitted with the necessary vaporizer. The usual hand fan h is provided for starting this fire, in conjunction with the blow off valve j. Water is supplied to the dust collector e by the funnel and syphon pipe k, a similar one at l supplying water to the rotary tar extractor. The final suction to the engine is shown at m. The water seal n at the base of the dust collector enables the dust and a large portion of the tar to be deposited therein and withdrawn during the operation of the plant. The tar settling pit is shown at p. The National producer is very similar to the orthodox anthracite type built by this company. The generator operates in a similar manner to that of any ordinary producer working on anthracite or coke, and no more attention is required in the working of same. In place of the vaporizers a large cast iron dust catcher is fixed with a special water spray so that the gases are partially cleaned and cooled before passing along to the scrubbers. Any deposit which may be sucked over can easily be raked out through the water seal whilst the plant is in operation. The gas passes through a large coke scrubber for cooling purposes, and then through a rotary tar extractor which is specially designed for removing a large percentage of the impurities from the gas. Finally it passes through a dry scrubber filled with coke, wood-wool and sawdust, which ensures the gas being absolutely dry and clean before passing to the engine.

In some cases difficulty may be experienced or anticipated that the available waste product may not be sufficient to generate all the power required. This is provided for in the Crossley Wood Waste Plant owing to the fact of its being able to not only burn refuse but other forms of fuel as well, such as bituminous coal, anthracite, coke etc. In the gasification of ordinary average waste wood no steam is required, and therefore no steam vaporizer is necessary, but with anthracite, bituminous coal or coke, steam is required. It is obvious therefore that the plant suitable for gasifying any of these fuels must possess some form of steam raiser. The Crossley design is adapted to such requirements for by the simple turning of a water-tap a controllable quantity of water is admitted to the patent step fire grate and the necessary supply of steam is at once forthcoming. The result is that any mixture of fuels or an arrangement of such fuels may be used at will without complications.

The combination of fuel facilities is obtained by virtue of the Crossley Patent Step Grate and Air-lock Hopper. The use of the latter enables the power user to adapt any working depth of fuel to suit any particular requirements. The design of the hopper prevents the possibility of air being drawn in the plant when the fuel is being fed, and so removes the risk of the slowing down of the engine during the feeding of the plant. This is a most important point. This producer incorporates a Patent Step Fire Grate. Owing to its design the attendant is able to clean, poke, and maintain the fire in a constant state of efficiency with perfect ease, an accomplishment almost impossible in the older type of closed grate gas producers. The Step Grate is stated to be very efficient. The tarry matter, present in the gas as it leaves the producer, is effectively removed by a tar extractor, and may be sold or used for tarring purposes on the premises.

Fuels and Fuel Consumption

The following somewhat comprehensive list of refuse that has been at some time or another used in these producers will give some idea of their wide scope. It has been found quite feasible to produce power from:

Anthracite, sugar cane refuse, bark, bikaner coal, blocks, etc., cocoanut husks, coke, collie coal, cotton pods, safflower seed husks, shells, tea prunings, suitable non-caking bituminous coal, brown coal, crushed cotton seed, dried manure, dung cake, fruit stones, grape cake, sawdust, spent tan, wood refuse, ground nut shells, monkey nuts, jungle timber, lignite, mealie cobs, olive refuse, peat, prickly pears, rice husks, wood chippings, sunflower seed husks.

The quantities, of course, required by these various coal substitutes must be more or less a matter of speculation in the absence of definite data. Messrs. Crossley give the following figures as applicable to their plants.

Locomotive smoke-box char, 1½ to 2½ lbs. per B. H. P. hour; cocoanut shells, 1½ to 3 lbs. per B. H. P. hour; rice husks, 3 to 4 lbs. per B. H. P. hour; mealie cobs, 3½ lbs. per B.H.P. hour; olive refuse, 2 lbs. per B.H.P. hour; sugar cane refuse, 2 to 4 lbs. per B.H.P. hour.

A Large Wood Producer Plant

An example of what can be done in this direction is seen in the recent installation at Lonely Mine, Rhodesia, which was recently put down to replace a steam plant owing to the abnormal fuel consumption of the latter. There are 4 350 h.p. Crossley producers supplying 4 multi-cylinder Premier engines. The wood used is supplied in large pieces, as much as 10″ in dia. x 2 feet in length.

The engines have cylinders 17½″ dia. x 26″ stroke, 3 of these are 4 cylinder engines and one is a 3 cylinder engine. The larger ones drive A. C. generators direct and in parallel, and the smaller one an air compressor. The large engines are of 300 B.H.P. and run at 187 r.p.m. The interesting point about the plant, irrespective of its size, is the fact that it was very thoroughly tested and the results of this test throw considerable light on the subject of the waste wood producer as a whole. The makers guaranteed a consumption of dry wood fuel as follows:—

Full load .....2.0 lbs. per B.H.P. hour.
Three quar. 2.23 lbs. per B.H.P. hour.
Half load ....2.76 lbs. per B.H.P. hour.
Quarter .....3.9 lbs. per B.H.P. hour.

The actual fuel consumption at 80% of full load worked out at 2.07 lbs. per B.H.P. hour and 3.09 lbs. per K.W. hour, these being the figures for equivalent dry fuel consumption rate, and are 4% below that guaranteed. The cost of the fuel at this rate worked out at 0.20d. per unit. Interesting information was also given as regards the composition of the gas.

Calorific Values, (Gross)

These were determined by direct combustion of a known volume of the gas in presence of oxygen. The figures given represent B. Th. U. per cubic foot, at 760 millimetres pressure at 0 deg. Cent.

No. 1	148
No. 2	172
No. 3	160
No. 4	166
Average	161.5

A composite sample consisting of approximately equal proportions from each bottle was analyzed by means of a Hompels apparatus, with the following results:—

	Per cent. by volume
Carbon dioxide	1.8
Oxygen	2.5
Carbon monoxide	22.9
Hydrogen	15.4
Methane	1.0
Olefines (ethylene, acetylene, etc.)	Traces
Nitrogen (by diff.)	56.4

By calculation this gives a gross calorific value of 142 B. Th. U. per cubic foot. This figure cannot, however, be regarded as being so accurate as those obtained by direct combustion, in the Mahler calorimeter, owing to the limitation of technical methods of gas analysis in determining and differentiating small proportions of hydro-carbon gas. These results show the gas to be of high standard somewhat above the average for producer gas.

On the whole there appears to be no doubt about the efficiency of the refuse gas producer. As engineers, power users, and others become more acquainted with its obvious advantages, there is no doubt that it will replace the smaller steam plants still common in the British overseas dominions and elsewhere. Such plants can never be really economical of fuel and it must always be remembered that even if wood fuel is plentiful in any district, it cannot last an indefinite period, while pure refuse, of the various kinds mentioned, if not utilized for power production where power, and cheap power, is required, is simply so much money thrown away, a procedure which no industry with any pretence at stability can afford to tolerate.

PRACTICAL REFRIGERATING ENGINEERS' CONVENTION

In connection with the convention to be held in St. Louis, Mo., Nov. 1-2-3-4 next, we are in receipt of the following leter from the Canadian Ammonia Co., Detroit.

Gentlemen,—

Referring to recent correspondence in reference to publishing notice of the coming Convention of the National Association of Practical Refrigerating Engineers to be held in St. Louis the early part of November, it may have occurred to you the same as it did to us as to whether Canadians were eligible to attend this meeting.

We are therefore taking the liberty of quoting you from a letter just received from the National Secretary in Chicago, as follows,—

> "In reply to the inquiry in your letter of the 2nd inst., wish to say that at the Philadelphia Convention that portion of the constitution which refers to membership (Section 2, Article 6) was amended, striking out the words 'who is an American citizen,' and the section now reads,—
>
> "Section 2.—Any white refrigerating engineer who has had one or more years' experience in an ice-making and refrigerating plant and is of good moral character is eligible for membership through a subordinate association, or as a member-at-large if not subject to affiliation with a subordinate association.'
>
> "This change was made at the suggestion of the secretary last year and was made in keeping with the broad principles of the association so as not to penalize any one who might not be a citizen of the United States but who wished to perfect himself in the art and science of refrigeration engineering. The effect of this change has been felt in a small way at least, and since the last convention we have taken in seventeen new members residing in foreign countries as follows,—Canada 8, Mexico 1, Cuba 2, Australia 3, New Zealand 1, Hawaii 1, India 1. I am giving you these figures merely for the purpose of calling to your attention the wide expanse of territory in which the N.A.P.R.E. has become known."

If convenient, we would therefore appreciate your changing that part of the notice pertaining to those who are eligible to attend, to conform with the above.

Thanking you in advance, we are,
Very truly yours,
Canada Ammonia Co., Limited.

LARGE VARIETY IN APPLIANCES AVAILABLE

(Continued from page 30)

sible efficiency, and if coal is costing $5 per ton, about $1.30 is being wasted. If two tons per day are being burned, this represents a loss in 300 days of $780. It is obvious in this case that there is a case for applying some money to the purchase of instruments which will show where the loss is taking place, and enable conditions to be kept right after they are corrected. Half of this money would buy a good CO2 recorder and draft gauge which, if intelligently used, would pay for themselves in six months' use.

Conclusion

It is not within the scope of this article to go into the different classes of auxiliaries, as even to give a general outline of them would occupy far too much space. The idea is to point out to the young engineer and to the older one too, where necessary, the desirability of familiarizing himself with the different appliances now obtainable for the modern boiler room. Knowing their uses and their particular adaptability he will be in a position to advise as to what particular equipment or instrument will give the best results in the plant he is in, and show where the spending of a little money judiciously will be attended with profitable returns.

Remember that a steam plant is a manufacturing plant, and the lower the producing cost of steam is maintained the better chance he will have to share some of the profits.

Ballard Sprague and Co., Inc., of New York, have issued an illustrated booklet dealing with their specialized service in the construction of brick chimney stacks, linings for steel stacks, setting of new boilers, and general service in connection with foundations and construction work for power plants. The booklet contains a number of illustrations showing this class of work in various stages. On the last page is a table of chimney heights for different horse powers, and a table of maximum drafts with different heights of stack.

Small Steam Plant Shows High Efficiency

An Average Performance of 79 Per Cent. on a Plant of Only 800 Horsepower is Exceptional—Good Design and Attention to Heat Balance Make it Possible

FIGURES are now available showing the results of operation for six months of the Canada Paper Co.'s new boiler plant at Windsor Mills, Que., which is believed to have established a record in economy among paper mill steam plants burning coal.

The figures are particularly striking in view of the comparatively small capacity—the normal load being only some 800 boiler horsepower—while the item for fixed charges included in the cost of steam delivered compares very favorably with large modern installations.

Steam plants of less than 1,000 h.p. present the most difficult problems in balancing expenditures and returns. Features such as basements, overhead coal bunkers and extensive coal handling equipment, etc., can seldom be justified from a financial standpoint since no saving in labor is effected thereby, while instruments and auxiliary equipment represent a comparatively high proportion of the total cost and must be carefully chosen to ensure that the increased economy gained warrants the investment.

In the case of the Canada Paper Co.'s installation, further limitations were imposed by the fact that the new boiler house was built on the same site as the old plant which had been in service for over 30 years, and had to be built in sections to keep the mill in continuous operation. Actually the entire work was carried through without causing a shutdown of the mill.

The plant comprises three Goldie and McCulloch water tube boilers of the Babcock and Wilcox type, each containing 2,467 square feet of heating surface, equipped with superheaters and "Type E" stokers. Two boilers are normally in service operating at about 160 p.c. rating. Space is provided for a fourth unit.

Economizers are installed proportioned to suit the particular conditions of heat distribution and short gas passages and absence of steel flues between boilers and economizer ensures maximum utilization of all available heat in the gases.

The economizers are responsible for an increase in economy of approximately 5 p.c. under present conditions, while the superheaters are justified by eliminating condensation in the long steam pipe lines and in increasing the economy of the main engines. Changes are now being made to one of the engines to further decrease the steam consumption during the summer months so that no steam may be wasted to the atmosphere.

A coal bunker with capacity for two to three weeks' supply is arranged conveniently for filling the stoker hoppers by hand, the bunker being served by an incline conveyor from the crusher pit and track hopper, to which coal is delivered either from railway cars or from the yard storage.

Special meters are provided on the boilers to guide the firemen in obtaining maximum efficiency of combustion in the furnaces, and by means of a separate recording flow meter on the independent stream line to the auxiliaries is possible to keep a check both on the steam consumption of soot blowers, ash conveyor, etc., and also the times when they are used.

With the mill running six days per week the efficiency of steam generation in the boiler plant has been maintaind at around 79 p.c. average, including the Sunday banking, while a check run taken over seven weeks, with careful attention to weight of coal used and with periodic analysis taken of the calorific value, showed an even higher efficiency.

The following economic results are given. It will be noted that the steam and coal used per ton or pound of paper includes the heating of the mill as required during the months of March and April. For the purpose of comparing the cost of producing 1,000 pounds of steam with other plants the price and heat value of the coal must, of course, be taken into consideration. The figure of $7.50 per ton of coal is given as an average price.

Mill operation, 6 days per week.

Average daily paper production, 53.5 tons per 24 hours.

Kind of paper, news and wrapping.

Superheated steam delivered to mill per ton of paper (including heating mill as in March and April), 9.470 lbs.

Total coal used per lb. of paper (including Blr. Ho. Auxiliaries, banking over Sundays, and heating mill), .593.

Total coal heat units per lb. of paper (including ditto), 7,110 B.t.u.

Total coal heat units per 1,000 lbs. steam fr. and 212 deg., delivered to mill, 1.256,000 B.t.u.

Cost per 1.000 lbs. of steam (including coal at $7.50 per ton, 12,000 B.t.u. Labor and electric current for Blr. Ho. motors).

Superheated. d/d to mill 54.25c.

Fr. and at 212 deg. d/d to mill 45.30c.

Fr. and at 212 deg. generated 42.80c.

Fixed charges, including repairs. (15 p.c. of cost of plant), per 1,000 lbs. steam delivered to mill 10.6c

Cost per ton paper for coal (7.50 ton, 12,000 B t.u.) $4.45

For labor and elec. current in Blr. Ho. ..... .52

$4.97

For fixed charges (15 p. c. plant cost) 1.20

$6.17

The plant was designed and supervised under construction by F. A. Combe, M.E.I.C., consulting combustion and steam engineer, of Montreal, with the object of securing maximum efficiency with minimum cost.

(Mr. Combe has contributed the following explanatory notes and remarks regarding the efficiency of steam plants).

When one considers that an increase in steam plant efficiency of 10 p.c corresponds to a reduction in coal consumption of approximately 13 p.c., also that, in the case of paper mills, a saving of 10 p.c. of coal consumption represents a straight increase in net profits per ton of paper sold of from 50c to $1.00, it will be realized that the subject of economy in the steam plant is worthy of considerable attention to-day.

It is safe to say that savings of 10 p. c. to 30 p.c. in coal consumption can be made in the large majority of paper mills, especially the smaller ones, not altogether by better performance in the boiler house but, in a great measure, by a re-arrangement of the steam and heat distribution.

Statements made as to the performance of plants and mills are often misleading due to the fact that the terms used to indicate efficiency and steam costs are not clearly understood or defined, for instance.

Fuel consumption per pound paper. It is customary to mention as a factor in the efficient performance of a paper mill the "pounds coal per pound paper." Since the calorific values, i.e. the number of heat units contained in a pound—of the common grades of coal on the market to-day vary by 15 p.c. and over, a more correct indication of the efficiency is "Fuel B.T.U.'s per pound paper"; that is to say the weight of coal or fuel burned per pound of a certain grade of paper multiplied by the heat units in a pound of the fuel.

Cost of Steam Production. Similarly the cost per 1,000 lbs. of steam delivered from a boiler plant is often vaguely stated without reference or consideration to the quality of the steam produced or the temperature of water furnished to the plant. These factors may cause a variation of anywhere up to 20 p.c. in amount of coal used alone, as it will be clearly seen that more heat is required to generate steam, say, at 200 lbs. pressure and 150 deg. superheat from water at a temperature of 60 deg. than to generate steam at 100 lbs. pressure without superheat from water at 200 deg.

To compute the efficiency of steam generation and to have a common ground for comparison of steam production by boilers and boiler plants operating at

different steam pressures, degrees of superheat and supplied with water at different temperatures, it is necessary to correct all such conditions of pressures and temperatures to a single basis. This basis is taken as the equivalent amount of water at 212 deg. evaporated into steam at the same temperature, (atmospheric pressure), or, as it is commonly termed "lbs. water from and at 212 degrees."

The output efficiency of the steam plant alone is, then, indicated by the total heat units in coal supplied to the plant per 1,000 lbs. steam fr. and at 212 deg. delivered from the plant; and the economic performance is the total cost of 1,000 lbs. steam fr. and at 212 deg. delivered, including fuel, operating expenses, and fixed charges. In this way adjustment is made for the amount of steam or hot water returned from the mill to the boiler plant, which is a debit, and also for the pressure and superheat of the steam.

Efficiency vs. Economy.—Efficiency and economy are not synonymous in the matter of generation and utilization of steam. While efficiency is a measure of the percentage of heat usefully employed, economy considers the total cost of production, and the latter is, of course, the important factor from a business standpoint.

The aim in design and operation of a steam plant must be to utilize in the most efficient manner the fuel—not necessarily of the lowest price per ton—which will give the greatest production of steam for a dollar, taking into account cost of fuel, labor, auxiliary power, fixed charges and repairs on plant. In other words steam should be treated as any other manufactured commodity.

The economical utilization of steam in the mill or factory must be considered in conjunction with the boiler plant as a complete system of heat exchange and recovery. To treat them separately cannot give the best results since on such a heat balance depends the advisability of using superheated steam and, in a large degree, economizers.

It is possible to illustrate in simple diagrammatic form where all the heat units purchased as coal go to in a mill as compared with the actual requirements. Such a diagram of an existing plant generally reveals where unnecessary losses occur or where heat can be used to better advantage, not only in the boiler room but in heating, power and process systems in the mill.

No arbitrary statements can be made as to the limits in size or the type of a boiler plant to justify the installation of such features as economizers, superheaters or mechanical stokers, as each case is governed by some special conditions and by the heat balance of the system, and must be judged by itself.

The above remarks may seem obvious to many, but they are usually not sufficiently studied in the design of, or in additions made to, plants, and the resulting waste of fuel is very high. In the majority of cases this waste can be largely overcome by comparatively small expenditures intelligently made in remodelling, yielding returns of over 100 p.c.—Pulp and Paper Magazine.

MAKING TURBINES NOISELESS

H. H. Lupinski, Westinghouse Electric & Manufacturing Co.

As every engineer knows, the steam turbine is decidedly superior to the reciprocating engine for producing electric power because of its higher fuel economy, smaller size, and lower first cost. But, on the other hand, some of the first installations of turbines in hotels turned out to be very noisy, so that preference has been usually given to engines under conditions where quiet operation is essential.

The engineers of the new Hotel Ambassador at New York were not satisfied to follow this practice, however. They preferred to use the more efficient turbines, if it were possible to do so, and felt convinced that if the machines were properly installed, their slight hum could be suppressed. They, therefore, drew up specifications for a thoroughly modern plant for the Ambassador.

The equipment specified consists of three 200-horsepower non-condensing Westinghouse turbines, each of which drives a 200-kilowatt, 250-volt direct-current Westinghouse generator. Special attention was given to the turbine foundations in order to prevent the vibrations of these high-speed machines from being transmitted to the structure of the hotel. The foundations were to consist of a concrete block which was to rest on a two-inch bed of sand and was to be separated from the building's foundations by a thick layer of cork on three sides and an open space on the fourth side.

In spite of these precautions, however, the turbines could be heard in many parts of the hotel as soon as they were started up. Puzzled at this apparent failure of their plans, the engineers made a thorough examination of the installation and soon located the trouble. In pouring the concrete block, the cement had leaked out into the cork and the sand, and had formed a solid mass, thus destroying the sound-absorbing cushion that had been prepared. These defective foundations were therefore torn out and new ones laid. The rock was levelled, brought to an even surface with cement and the four sides enclosed with 8-in. brick walls up to the floor finish, the whole of which was then waterproofed. A 2-in. layer of hair felt was placed on the bed, and a 2-in. layer of compressed cork placed on top of that. Then came another layer of felt and another of cork, and this same insulation was returned up the face of the brick walls to the floor level. The interior surface was again water-proofed with 5-ply membrane felt and pitch, this returned over the top edge of the side wall insulation. Into this insulated water-proof box a concrete block was carefully poured, which extended over the side wall insulation with brass drip strip cast into the foundation.

This new arrangement solved the problem. Even in the grill room, which is directly above the turbines, not a sound from the engine room can be heard.

Another interesting feature of the Ambassador's power plant is the method used to regulate the steam supply. In order to eliminate boilers, with their smoke, dirt and trouble, steam is not made on the premises, but is obtained from the New York Steam Company. It comes in at 160 lbs. pressure, passes through the turbines, and is exhausted by them at a pressure of 7 lbs. This exhaust steam is used for heating, making hot water, operating the absorption refrigerating machinery, and for various kitchen and laundry purposes.

The largest part of the demand for steam is, of course, for heating; and if the turbines were operated with the same load all year round, a large amount of steam would necessarily be wasted during the summer months. To avoid this, a supplementary supply of electric power is obtained from the New York Edison Company.

In winter, therefore, two turbines are regularly in use (with the third as a spare), and these supply all the steam and most of the power required. In summer, however, the exhaust from one turbine furnishes all the steam needed, so the other one is shut down, and a much larger amount of electric power is drawn from the central station. A special switchboard, built by the Westinghouse Company, permits various combinations of circuits to be supplied by either the turbines or central station, in accordance with the demands for steam. In this way, the most economical ratio of purchased steam to purchased electricity can be constantly maintained.

ENGINEERS AND THE POWER EXPOSITION

(Continued from page 27)

The Exhibition is fortunate in having an Advisory Committee that understands the importance of a greater popular appreciation of the engineering problems involved in the production and use of power. The Committee is made up of Irving E. Moultrop, of the Edison Electric Illuminating Company of Boston, chairman; Dexter S. Kimball, president National Association of Stationary Engineers; Milan R. Bump, president National Electric Light Association; N. A. Carle, vice-president Public Service Production Company of New Jersey; E. B. Katte, chief engineer Electric Traction N.Y.C.R.R. Company; Fred R. Low, Editor "Power"; David Moffat Myers, consulting engineer; Calvin W. Rice, secretary The American Society of Mechanical Engineers; and the managers, Charles F. Roth and Fred W. Payne, with offices in Grand Central Palace.

Member of the Audit Bureau of Circulations

POWER HOUSE

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The U. S. and Canadian Associations

IT IS interesting to note, that in the opinion of one of the leading power engineering journals in the United States, that the National Association of Stationary Engineers is not living up to its opportunities. The N.A.S.E. occupies the same position in the States that the C.A.S.E. occupies or should occupy in Canada. The American Association has been in existence a few years longer than the Canadian, and, of course, has a much greater membership. In an editorial comment "Power" points out that while at the recent convention of the Association, the delegates' mileage came to $29,000, and $12,000 in addition were appropriated for salaries, expenses, and committee work, the Educational Committee got only $400. While some good work has been done by the Educational Committee, in the past, it would seem that the membership as a whole has not taken the interest in education that would seem likely in a body of that kind. The commentor offers the opinion that the fault is in trying to make one particular line of educational work fit a largely diversified body of men.

This is one of the great difficulties in conducting an educational program in an association of the type of either the C.A.S.E. or the N.A.S.E. although the problem in the case of the N.A.S.E. should, we imagine, be more simple than that of the Canadian Association. In local branches which contain a large membership it is possible to split the members up into groups, and provide fitting instruction for each particular group. In locals with small membership this cannot be done, and the educational work has to be conducted for the whole membership, and this inevitably results in what many of the older members look upon as lost time as far as they are concerned. In connection with the N.A.S.E. the editorial writer in "Power" puts forth the suggestion that the Association start an educational campaign on a systematic basis, leading to a professional engineering education. This is a real constructive idea, and one that might, with benefit, be considered by the C.A.S.E. The educational program adopted at present, while good in its way, does not lead anywhere in particular, and covers such a wide field that nothing of a very intensive nature can be accomplished in any particular subject. For instance, the subject for one evening's paper is "Boilers, Furnaces and Settings." The educational work at these meetings is not started as a rule until about 9 p.m. at the earliest, and supposing that all the members remain until 10.30, which is the exception, the time is limited. It is obvious that in such a length of time only the very highest spots can be touched, and the same thing applies to the discussions. We think that the subjects of "Boilers, Furnaces and Settings" could very well have an entire session devoted to it, instead of one night.

It is interesting to know that a large, strong society like the N.A.S.E. with such a large number of men to draw from, and every opportunity to give service, seems to be having the same difficulty in its way that the C.A.S.E. has been experiencing. Both associations claim to be first and foremost educational societies, and both of them seem to have the greatest difficulty in accomplishing anything of real value along educational lines.

As far as the C.A.S.E. is concerned, an attempt is being made, but it is questionable if it is along the right lines. We think that the Grand Lodge in annual session might profitably spend a little more time on this question. During the year the officers of each branch should consider what would be the best lines to proceed along and so instruct their delegates to the annual convention.

High or Low Pressure

IN STATIONARY engineering circles, a subject that has frequently caused considerable discussion, is whether it is more economical to use low pressure steam for heating, or high pressure with a reducing valve fitted between the boiler and the heating main. In this issue we have published a very complete investigation into the matter by Mr. Edgar Buckingham, of the United States Bureau of Standards. He shows in this that while it is true that the radiation losses are higher for the same pipe surface with high pressure steam, than with low, the high pressure pipe can be made of smaller diameter to offset this. The pressure loss due to friction in the smaller pipe, does not appear as a heat loss, where the steam is to be used for heating. The heat remains in the steam, and is available when the steam is condensed to water in the heating system. If steam is to be used for power, the heat loss is required in the engine or turbine, where it is converted to work, and any heat drop in the pipe is unavailable for conversion into power.

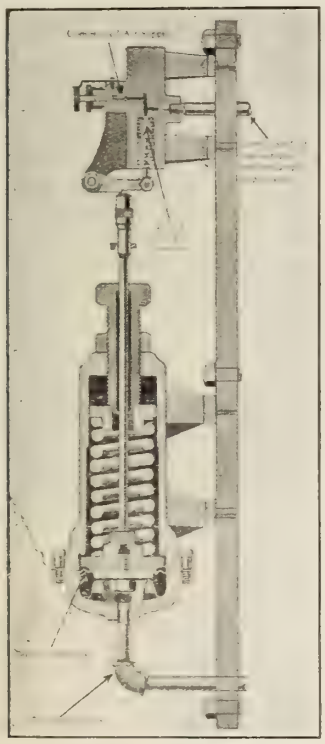
This investigation shows that in a plant that is to be used purely for heating, it may be more economical to instal high pressure boilers and piping, with reducing valves, from a point of view of saving in first cost. It also opens up the question of whether it might not be more economical, in the case of a plant using exhaust steam during the day time, and reduced live steam for nights and week ends, whether it would not be a paying proposition to instal a separate high pressure line to carry the steam to the heating coils, especially where the distance from the boiler room is great. The writer recalls a plant in which the power house was situated in the centre of the factory grounds, and the heating main was carried in a tunnel extending on each side a distance of about 100 yards to the basement of the building to be heated. These buildings were respectively 600 feet and 750 feet in length, and there were extensions besides. The heating main to the office had to run a distance of about 500 yards, with branches to other buildings taken off on the way. The main heating pipe was 24 inches diameter, and when no exhaust was available steam at 150 lbs. was reduced to 10 or 15 lbs. in the engine room, and delivered to this pipe. It was small wonder that coal consumption on a purely heating load was higher than on a power load, with exhaust used for heating.

Progress in New Equipment

THE GRAY AUTOMATIC CONTROL

The above system of automatic control is based on the principle that there is a certain over-fire vacuum, or draught intensity, which is the fundamentally correct one. At this draught there is the minimum tendency to cause influx of cold air into the furnace through the setting, and the velocity of the gases is such that the heat absorption is at a maximum. As the pressure in the furnace is below atmosphere, if only a slight amount, there is not the excessive radiation that exists with a positive pressure.

The Gray Automatic Combustion Control, manufactured by the Automatic Fuel Savings Co., Philadelphia and Chicago, is designed to keep a constant over-fire vacuum and steady steam pressure no matter what changes occur in the condition of the furnace. The regulation of fan and damper is controlled by an air pressure of 15 lbs. per sq. in.



Pressure Regulator.

through a regulator which is, in turn, actuated by the variation of pressure in the main steam pipe acting on the diaphragm. The regulator consists of a spring which is set to the required pressure to be carried on the boiler, and this

Vacuum Control.

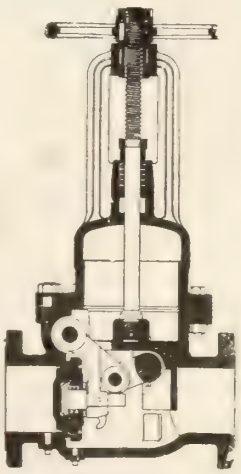
spring is opposed by a diaphragm which is exposed to the steam pressure. A spindle passing up through the spring and attached to the diaphragm carries a needle valve at its top end and this needle valve controls a port which gives access to the atmosphere. If the steam pressure drops, the spring overcomes the resistance of the diaphragm forcing it down. This opens the needle valve to the atmosphere and the compressed air which in turn is acting on diaphragms controlling the damper and fan is allowed to escape thus opening the fan and damper control.

The over-fire vacuum control is effected as follows: The furnace air controller is set for whatever over-fire draft has been determined as being the best for the fuel, and any alteration from that draft, however slight, will cause the air to act and restore normal conditions. The controller comprises an exaggerated U tube partly filled with non-evaporating oil. It is connected to the furnace chamber above the fire by means of a draft pipe. An element which floats upon the oil is fastened by an arm hinged to the side of the compressed air leak port. As the furnace draft or vacuum increases or decreases the U tube oil level is raised or lowered. This action causes the arm fastened to the float to open or close the compressed air leak port. The operation can be summarized thus: Upon a sudden demand for more steam the steam pressure controller opens the damper. The greater damper opening increases the furnace vacuum, which in turn registers on the vacuum pipe connected to the U tube of the controller. The increased vacuum raises the level of the oil on one side and lowers it on the other, carrying the float. The downward movement of the float brings the arm to rest on top of the leak port, closing the escape of air to the atmosphere. Compressed air pressure then builds up under the diaphragm operating the steam valve to individual turbo blower or wind blast gate. The blower speeds up or the blast gate opens sufficiently to build up the under-grate pressure and bring the over-fire vacuum back to the predetermined and desired point.

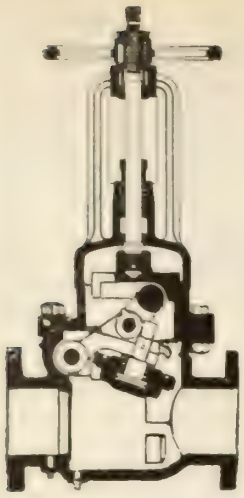
A NEW REGRINDING VALVE

The regrinding gate valve shown in the accompanying illustrations has been designed for high pressure steam and high superheat pressures up to 300 lbs. per square inch and temperatures up to 750 degrees F. have been allowed for. The body of the valve is made of cast steel, and the valve seatrings of nickel composition. The valve is made so that when it is in the open position, the opening is of the same area as the pipe itself, and for this reason there is practically no tendency to wiredraw, and the drop in pressure from this cause is practically eliminated.

Among the advantages claimed for this valve are no obstruction to steam flow, or change of direction. Higher effective working pressure can be utilised. Higher rate of steam flow is possible than with an ordinary mushroom valve, and for this reason piping of smaller size can be used, reducing the first cost of pipe installation. Loss of heat by radiation is reduced owing to smaller pipe sizes. Ease of valve operation is secured due to the special toggle lever movement. The valve disc is



View with valve closed.



View with valve open.

readily accessible for regrinding without dismounting the valve. Minimum cost of operation and upkeep is insured.

The valve seat is at right angles to the horizontal axis of the body. Closing is effected by the disc which is rigidly connected to a swing link suspended on a shaft. Attached to the swing link is a threaded disc stud which is secured to the valve disc by means of a disc nut. The disc is so designed as to insure a perfect seating of the contacting surfaces. The purpose of the spring shown is merely to prevent vibration of the disc and at the same time to give a slight flexibility of operation.

Opening and closing the valve are accomplished by means of a sliding carriage that moves at right angles to the horizontal axis of the body. This carriage slides practically without friction. It is rigidly attached to the vertical rising spindle and can be made to move up and down by turning the hand wheel.

A forked link is connected by pins with the sliding carriage and the swing link. This forked link is inclined slightly from the horizontal and forms with the slide a toggle lever that exerts pressure against both the swing link and the disc, thereby forcing the disc firmly against the valve seat.

Lugs are provided in the housing for limiting the downward movement of the slide in instances where the packing rings are especially worn either because of excessive grinding-in of the valve or for any other reason.

There is no side thrust on the rising spindle when the valve disc is being raised from the seat, because the slide is concentrically mounted in the housing with a snug fit, and furthermore because it extends around the vertical axis of the housing shows that the seat rings of the disc are well protected when the valve is open.

In order to grind in the valve seat, the bolts binding the bonnet to the housing are first removed. Then the pin connecting the forked link and the swing link is removed and all the internal parts are taken out with the exception of the swing link and the valve disc. The grinding operation is performed in the customary manner by adjusting a suitable wrench in the end of the disc stud, inserting the extension of the wrench into one of the holes provided around the circumference of the valve disc and by rotating the disc alternately clockwise and counter-clockwise, at the same time exerting pressure against the valve seat.

The valve disc in its highest position is so located that the seat rings are above the flange of the valve body when the bonnet is removed. Thus the rings are conveniently accessible and can be readily inspected whenever necessary.

The valve is made by the Schutte and Koerting Co., Philadelphia.

A HUNDRED-INCH SLIDE RULE

Every engineer is reputed to carry a slide rule and to use it a hundred times a day for every conceivable kind of calculation. The ordinary pocket slide rule is, however, not accurate except within rather wide limits; and, when a finer margin of error is desired it is necessary to employ a rule of larger dimensions. A British firm has recently brought out a slide rule in which the scale is 100 in. long and can therefore be relied upon to yield results in multiplication and division with an error of less than one in one thousand. The scale is arranged in twenty parallel lines, each about five inches long; and the whole thing is arranged so that the rule can be operated with one hand while the other holds the pen for recording results.

TEMPERATURE REGULATOR

A device for automatically controlling the temperature of electric, oil or gas furnaces has been placed on the market recently. The furnace temperature can be held within a 10 deg. F. range. The control mechanism operates automatically at 30 sec. intervals. When the furnace is operating within 8 deg. F. of the desired temperature, a white signal light is visible at the top of the board. Variation from the limited range high and low is indicated by red and green lights respectively. The mechanism operates the control switch, so that the error is corrected before it has deviated more than 10 deg. from the desired temperature. The control is claimed to be positive and automatic. The case of the instrument is made of cast iron and has a black enamel finish. It weighs approximately 27 pounds. These regulators are made by the Hoskins Mfg. Co., Detroit, Mich.

LONG-LIVED BRITISH MACHINERY

The capacity of British engineering productions to withstand many years of hard work is proverbial. British manufacturers have maintained their high standards in spite of the strong temptations of competition with inferior goods which are claimed to be just as good. In keeping up this standard these firms are maintaining a very ancient tradition. A short time ago some rolling mills in the north east of England were dismantled. These mills were established in 1691, and the old rolls and other machinery are still in existence. The water wheel employed is also still in working order. It was, as a matter of fact, used by the dismantling firm to operate the shears in cutting up the scrap ironwork derived from the works.

BOOK REVIEW

The "Union D'Electricite" has issued a book, printed in English, giving a fully detailed and illustrated description of the Gennevilliers Station in Paris. The book is edited by the Revue Industrielle, 57 Rue Pierre-Charron, Paris, and translated into English by C. M. Popp. It gives not only a description of the Gennevilliers layout but deals with the general scheme of electrical distribution in and around Paris in pre-war days, and the developments of which the Gennevilliers is a part. The book costs only $1 to any country in the Postal Union, and will be supplied to publishers or booksellers for 60 cents.

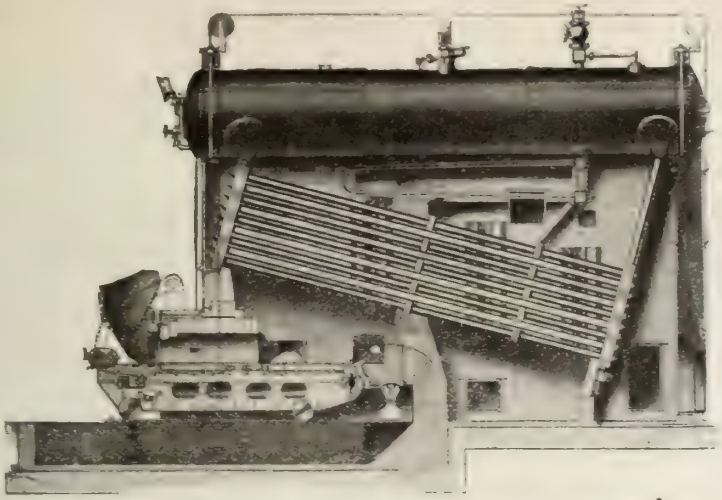
We have received a second edition of Crain's Market Data Book and Directory of Class, Trade and Technical Publications. This book gives a general review of every trade, industry and profession in the U. S. and Canada, and a list of the publications devoted to the interests of each.

CATALOGUES

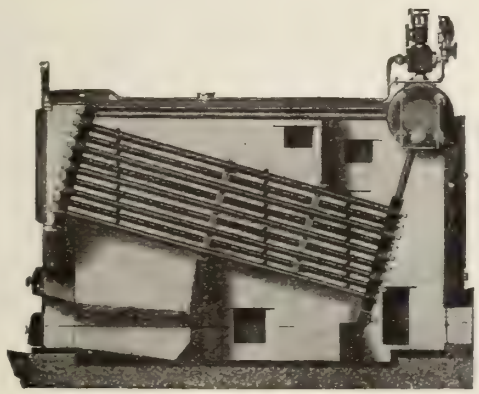
Line Shafting Equipment is the title of the latest catalogue, No. 43, issued by the Medart Co. of St. Louis, Mo. The first part of the book contains a brief description of their method of manufacturing shafting, while the remainder is devoted to the listing of a wide range of products used in transmission of every character. In addition to being a catalogue the book contains many tables and engineering data that make it very useful as a textbook.

Canadian Ingersoll Rand Co., Sherbrooke, Que., have issued bulletins K701 and K702 describing their electric, steam, and air hoists. Complete details of construction are given, and photographic views, also line drawings of the general arrangement of the different types.

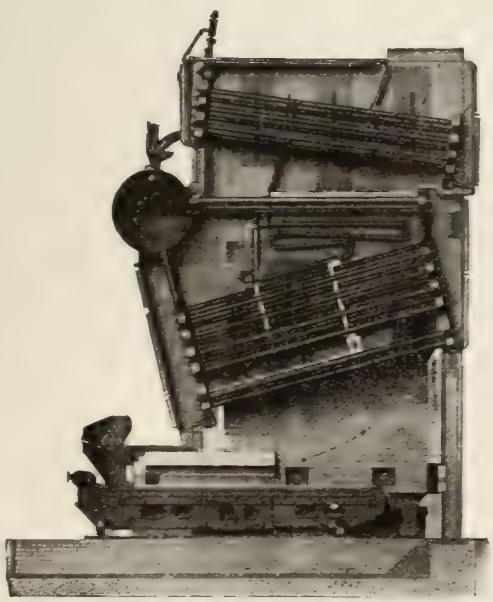
Edmonton.—Coal production in the Drumheller fields has amounted to 6,825 tons daily and will shortly be increased to between 8,000 and 9,000 tons. All the coal camps in Alberta and Eastern British Columbia are now working, and much of the product is being shipped to Saskatchewan and Manitoba. It is expected ample coal will be mined to meet all the requirements of Western Canada. The longest distance that Alberta coal has been shipped was recorded here when a local colliery forwarded a carload of egg coal to Levis, Que.



W. I. F. TYPE—With chain grate stoker and superheater suitable for most purposes on land.



CROSS-TYPE—A most desirable form of boiler where headroom is limited.



MARINE TYPE—(For land purposes). The marine-type boiler is equally adapted for installation on Land and is especially suitable for electric generating stations and other quick steaming plants. Where ground space is limited, and expensive, it offers particular advantages.

EFFICIENCY DURABILITY SAFETY

THERE IS A TYPE

OF

B. & W. BOILER

TO SUIT EVERY CONDITION ALL HAVING THE SAME PRINCIPLES OF CONSTRUCTION, VIZ:—

Water divided into sections, no general explosion can occur.

Every section able to contract and expand without interfering with any other part of boiler.

Boiler as a unit can move without disturbing setting.

Positive circulation of the water keeps all parts at nearly uniform temperature.

Proper workmanship.

Materials which experience has shown to be the best for the particular purpose.

A great excess of strength over legitimate strain.

No joints or cast metal exposed to the direct action of the fire.

Perfect circulation of both water and gases. Proper proportions for work to be done at any rating.

Ample water and steam capacity and water space for disengagement of steam.

Scale forming materials and soot can be removed while boiler is working.

All parts readily accessible for cleaning and repairs.

Adaptable to any furnace burning any fuel, solid, liquid or gaseous.

No restrictions to draft.

QUICK STEAMING.

Write for Full Information

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LIMITED

ST. HENRY, MONTREAL

Toronto Office: Bank of Hamilton Bldg.

Some Pointers on Burning Wood Fuel

Wood Fuel for Boilers Often Contains a Large Amount of Moisture—Effect of Moisture on Heat Value—Kind of Furnace Required for Burning Wood Fuel—Higher Chimney Required

By "JOHNNY SHOVEL"

OF COURSE you have noticed that people who live in the bush spend their holidays in the city. Well, we are like that. When we have our choice we take them late enough to miss the hot weather and we enjoy every minute of the time visiting around with the boys at the big power plants, making the rounds of the book stores, libraries, shows and doing everything the city man never thinks of doing.

This year we got another form of diversion. On invitation we went to the meeting of the C.A.S.E. on the night when the first subject of the yearly program was up. The general subject was Fuel and the proceedings started with a paper on Coal. We thought that there were enough good points in it for a month of discussion, but the chairman choked off the talkers and got another man started on Oil.

Even the hard working chairman couldn't prevent a certain amount of discussion while the "oil" man was on the floor, and the hour was late when at last an end was made of it to hear the man who was to talk on Wood. We are particularly interested in wood as a fuel so we listened with wide open ears to get what he said. This is what we heard and a lot of it is gospel truth.

First he remarked that it was hard to classify the methods of burning wood because nearly every place did it after a fashion of their own, and many of them with no particular method at all. But, as he had to start somewhere, he figured to talk about three classes based on the moisture which each particular sort of wood contained at the time it was fired.

Different Degrees of Moisture

In his first class he put the waste from logs taken straight from the mill pond. Such fuel would contain from 40 to 60% moisture and although the quantity of hard and soft wood might be just the same as in any other class, the arrangements for handling the waste, and the furnace would be very different and the amount of useful heat much less than from the second class, all because of the higher percentage of moisture.

In his second class he put the waste from timber which had previously been sawn to size and piled up for drying. Usually there was a lot of kiln wood in this class and the maximum moisture was not over 25%.

His third class included the fuel containing from 25% to 40% moisture.

We could imagine a great number of combinations of wood and of degrees of moisture, which would cause these classes to overlap a great deal, because one company may and often does saw, dry, plane and otherwise complete the whole series of operations required to produce the manufactured article. But the same method for figuring the useful heat would apply to all of them.

Heat Value

He showed us a table giving the heat value per pound of dry oak and six or seven other kinds oftrees and we were surprised to see that soft woods give a higher B.T.U. than hard woods. A discussion started over the reason for it and several aired opinions, but we decided for ourselves that the balsam or resin in the soft woods gives them the higher heating value.

As for that though, with the men in the woods cutting everything as it comes and the sawdust and so forth coming to the furnaces in proportions depending on the orders the mill has to get out, it is impossible to know the B.T.U. without taking continual tests with a calorimeter. For ordinary purposes all wood can be considered to have the same heat value per pound when dry and on average figure of 8,600 B.T.U. is near enough. The moisture contained is the important thing, because it determines what heat will go to make steam.

There were some who expressed wonder that wood containing 40 to 60% moisture could be useful for fuel, so the heat available was worked out on the blackboard for a sample containing 52% moisture, which means there was only 48% fuel. He took 8,600 B.T.U. as the total heat, and 48% of it leaves 4,128 B.T.U. in one pound of fuel as it goes into the furnace.

But the only means for getting rid of that 52% of water is to shove it up the stack as steam. This steam will be as hot as the stack gases, probably around 500° F., or in other words will be superheated at atmospheric pressure. Therefore, though the 48% of real fuel gives us 4,128 B.T.U., we have to use a good part of it in making steam of the other 52%.

To raise one pound of water at 62° F. to 212° F.	150 B.T.U.
To evaporate one pound of water takes (say)	970 B.T.U.
To raise one pound of steam to 500° F. ..... (Because superheat takes ½ B.T.U. to 1° F. raise in temperature).	250 B.T.U.
For one pound of water ...	1370 B.T.U.
For 52% of one pound of water	702 B.T.U.

4128—702 = The useful heat = 3462 B.T.U.

This looks small compared to soft coal at 13,000 B.T.U. per pound dry, and we should have to fire nearly 4 pounds of wood for one of coal, but if the wood costs nothing the only worry is to see that it is used economically enough so no coal will be burned.

Speaking of economy brought up the questions of cost of burning wood, and it was brought out that very few places use any large pieces of fuel. There were two reasons, first because in a modern saw mill everything of any size is marketable either as timber or for furnace and stove wood.

The only solid stuff consists of long slender pieces, known as "edgings" and thin slabs both of which are put through a machine called the "hog" and made into shreds and chips of which the largest is perhaps an inch by four inches long.

It is cheaper to "hog" this than to handle it by hand and besides both edgings and slabs are uneconomical to burn in that shape because of the excess air which would get through such an open fire. When they are burned it is usually done in a special furnace.

All the small waste from the machines is burned with the hogged fuel. Most of it is saw dust, some quite fine, some ¼-in. to ⅜-in. long, some from the shingle machine looks like excelsior. All the waste, including the hog product, is wet and too heavy to be handled from the mill to the furnaces by fan blast. Drag conveyors, endless chains pulling scrapers in troughs of wood or steel, move the fuel satisfactorily if not quite so handily as fans. It unloads by gravity through holes in the trough and chutes leading to the furnaces, the quantity being controlled by slides covering the chutes.

Kind of Furnace

The high moisture makes it necessary to burn the wood in a large, high furnace of the Dutch oven type so there will be enough brickwork to radiate the heat to evaporate the moisture and plenty of space for the gases and air to mix thoroughly. We were impressed with the fact that the steam mixed with the gases makes it more difficult for the air to get to them and mix with them and burn before they get out of the combustion chamber.

It was pretty plain from the questions asked that very few had any means for controlling the quantity of air and that some of those who had dampers on the incoming air did not require the firemen to operate them. Nothing was said

Detroit V-Type Stokers Insure Satisfied Tenants

Group of Garment Center Realty Buildings, New York, Equipped With Detroit V-type Stokers.

Tenants of public buildings demand service. They want hot water, elevator service, heat, light and power, instantly available at all times. The ability of the building management to render the service required is dependent upon efficient boiler operation. That is why Detroit V-Type Stokers are installed to-day in hundreds of public buildings.

Typical buildings equipped include:

Ellicott Square Building, Buffalo, N. Y.
Fayette National Bank Building, Lexington, Ky.
Federal Reserve Bank Building, Cleveland, Ohio
Garment Center Capitol Co., New York City
Metropolitan Bank Building, Minneapolis, Minn.
Morewood Building, Pittsburgh, Pa.
Munsey Building, Washington, D. C.
Nicholas Building, Toledo, Ohio
Pittsburgh Life Building, Pittsburgh, Pa.
Ponce-de-Leon Apartments, Atlanta, Ga.
Spitzer Building, Toledo, Ohio
Sun Life Building, Montreal, Quebec
David Whitney Building, Detroit, Michigan

Detroit V-Type Stokers are a profitable investment because with them: (a) average overall boiler efficiencies of 70-75 per cent may be maintained, (b) one man can handle up to 1200 H. P. of boilers, (c) cheaper grades of fuel can be burned than with hand firing.

On every score your boilers should be equipped with Detroit Stokers. Remember, there is a type for every purpose—V-Type Overfeed for natural draft—Single Retort Underfeed for forced draft with boilers developing up to 300-400 H. P.—Multiple Retort Underfeed for large boilers.

Ask for Bulletin 338

DETROIT STOKER COMPANY

Underfeed Forced Draft and Overfeed Natural Draft Stokers

338 GENERAL MOTORS BLDG. DETROIT, MICHIGAN

SAVE FUEL "DETROIT V TYPE STOKER" AND LABOR

about a damper regulator but we concluded that as excess air must be guarded against just as carefully as with any other fuel, it would work well.

After telling us how the fuel should be handled in the furnace, the paper gave a few details of the equipment. For one thing the stacks should be higher than for coal, because the fuel is piled up 6 or 8 inches deep on the grates even in the corners and an intense draft is necessary to get even enough air through to keep them cool. It must be larger too to enable it to handle the steam from the moisture in the fuel. He figured that to play safe it was advisable to allow only 25 to 30 sq. ft. of heating surface to one of grate surface and that one sq.ft. of grate should not be expected to develop more than 3 to 4 HPmax.

Burning the refuse from wood of the second class, say from a wood working factory, is a different matter altogether. This stuff is air dried if not better and the average usually below 25% moisture. The waste consists mostly of fine saw dust and shavings, that is chips made by the planers about ¾ in. square and anything up to ⅛ in. thick, which is readily handled to the furnaces by fans.

The useful heat is higher because less moisture is contained in the wood. It is arrived at by the same method as we used for "hogged" fuel. Probably we would only have to fire 2 to 2½ lbs. of this wood to equal one pound of 13,000 B.T.U. coal.

No special brick work is required to burn it, but a high setting gives the air the chance to mix with the gases in the steam to complete combustion.

The fuel is not allowed to pile up on the grates, in fact it mostly burns in suspension in a firebox filled with flame. Care should be taken that the furnace is not too large as it is an easy matter to waste the shavings. By studying the flame the length of it can be determined and the grates set so all flame is complete before it comes in contact with the metal of the boiler. Loose bricks can be used to get the right size of the firebox. Fill in the furnace till the grate exposed will just give you your peak load, add a bit more for safety and then brick in permanently.

The same care about excess air is necessary as with any other fuel and this class of wood refuse will give a high CO_2 if the dampers are properly maintained and operated.

All that he said about the first two classes of fuel applied to the third class. The furnace for this class would probably be of what is known as the extension type, which would give a larger grate than a flush front and some [illegible]

Glace Bay, Nova Scotia.—With all its collieries working, the output of the Dominion Coal Company's mines is rapidly approaching normal. The average output of the mines is 14,000 tons a day, and officials of the company expect to reach this figure in a short time.

PECULIAR WATER LEVEL TROUBLE

By T. Parkes,
Master Mechanic, Crabtree Mills

The following occurrence may be of interest to Power House readers, as it was the source of considerable trouble to me at the time.

We have our boilers numbered 1, 2 and 3 respectively. Nos. 1 and 3 are B & W double drum type, 300 horse power, and No. 2 is a single drum, 175 horse power.

About one year ago we experienced a great deal of trouble with No. 3 boiler owing to the difference of the height of water shown in the gauge glasses on each drum. For instance, when the boiler was operating at normal rating No. 2 drum would show 2 inches more water than No. 1 drum, and when operating at 120 per cent. rating the difference would be 5 inches. When run up to 160 per cent. rating, as frequently occurred, the water in No. 2 drum would almost disappear from the glass. Frequent internal inspections failed to reveal the source of the trouble, as the boiler was in excellent condition internally. The water we use is very soft and we do not use any compound, so we could not accuse this agent of causing the trouble. Still looking for a cause I got an idea that the dry pipe might be the guilty party, so I gave orders for the pipe to be removed. There we found the nigger in the wood pile.

The pipe was found to be broken on the top, a piece about six inches square being broken away. This would be equal to an area of about 36 square inches. What had broken it is still unknown to me, unless it was defective when first put in. We welded the piece in place again and the water trouble disappeared.

On the sketch I have marked the place where the pipe was broken and as I have previously mentioned the dry pipes are perforated on the top side, obviously the steam passage is partially restricted.

Now supposing we were operating No. 3 B & W (normal rating 300 h. p.) at, say, 150 per cent. rating or 450 B.h.p., steam 13,500 pounds per hour. The total pounds of steam would have to pass through four connecting tubes as shown in sketch, dimensions of which are 3¾ in., inside dia. 5 in. long.

Now at 140 lbs. pressure the velocity of the steam passing through the four tubes will be approximately 2,000 feet per minute.

Now if we chose to close the steam outlet of No. 1 drum, naturally the total quantity would have to pass through the two tubes of No. 2 drum, namely 13,500 lbs. We would also find that the velocity of the steam is 4,000 feet per min. instead of 2,000.

For simplicity suppose we were to remove the dry pipe from No. 2 drum which would represent conditions just as we found them.

What would probably occur?

My opinion is that we would have a combination of pressures, dynamics and statics actually taking place in the drums.

Dynamic pressure in No. 1 static in No. 2 drum.

Therefore it would seem that the load on No. 1 drum will be at rest, so to speak, and the velocity of the steam leaving No. 2 has greatly increased.

Consequently the pressure in No. 1 drum will be somewhat higher than No. 2. Whereby the pressure difference

(Continued on page 44)

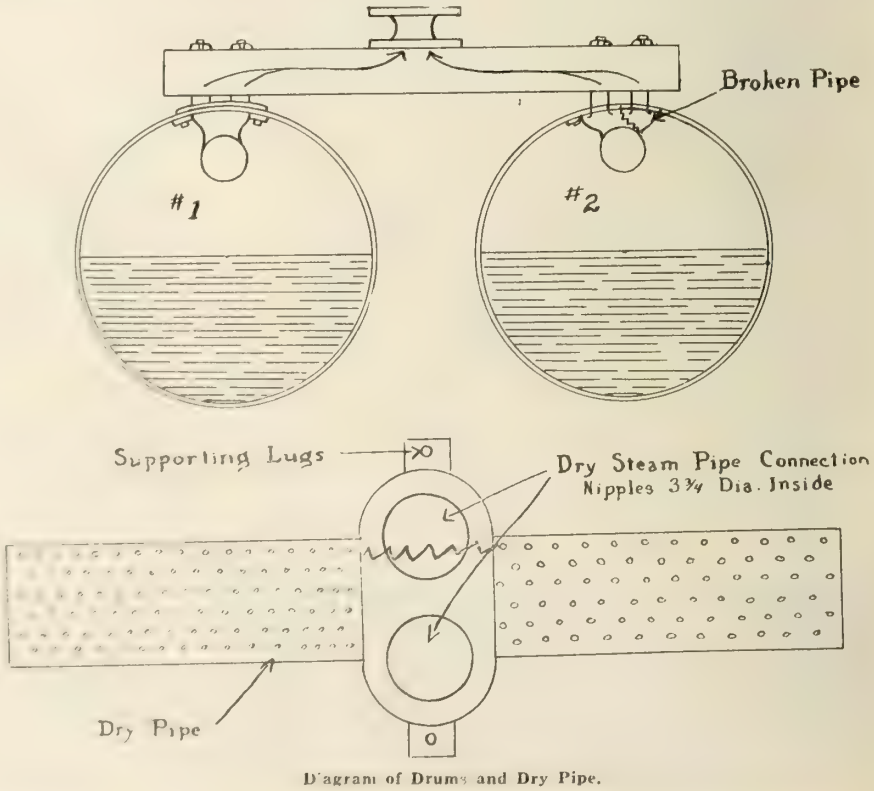
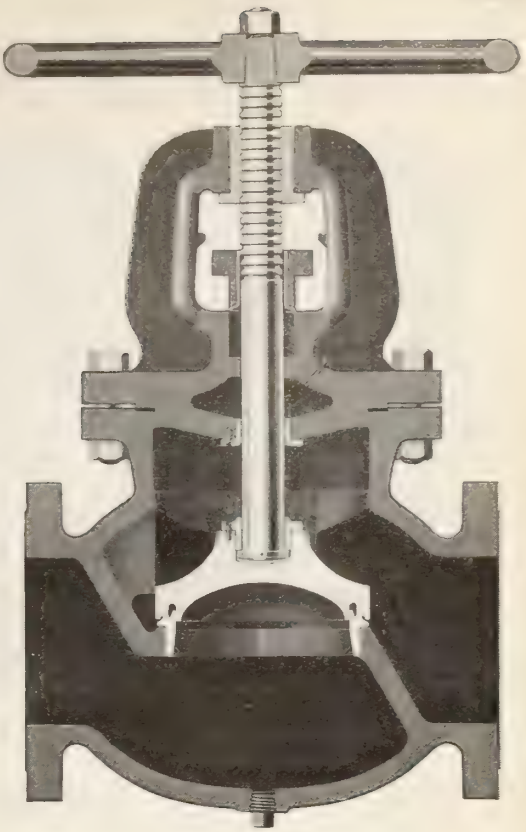


Diagram of Drums and Dry Pipe.

Edward Valves

Stop Valves
Non-Return Valves
Check Valves
Blow-off Valves

Forged Steel Valves—Union Fittings



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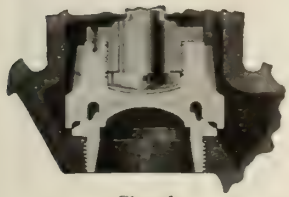
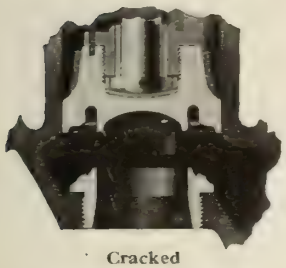
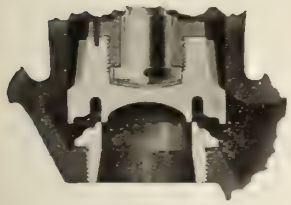


Closed



Cracked



Open

All EDWARD Valves have the Edward Protected Seat and Disc

The Edward Protected Seat and Disc, shown above, insures absolute protection of the most vital organ of the valve anatomy, *the seating surface.*

Unless positive means of prevention is provided, the cutting from wire drawing between the seats and disc of a valve will rapidly destroy the seating surfaces. This is especially true under high pressures and temperatures, where very small leaks will rapidly grow on account of the terrific erosive action making the life of the valve very short and increasing the upkeep cost due to frequent repairs and renewals.

In the "cracked" position the erosive action of the steam is greatest, due to the fact that the steam is being wire drawn through a very small orifice and its velocity thus greatly increased. The illustrations show the positive protection which the EDWARD PROTECTED SEAT and DISC affords against this cutting action. Note that in the "cracked" position the seating surfaces are widely separated and protected from the direct flow of steam and that the velocity across the seating surfaces is greatly reduced.

Send for catalogue describing the EDWARD line

The Edward Valve & Manufacturing Co.

General Offices and Works:
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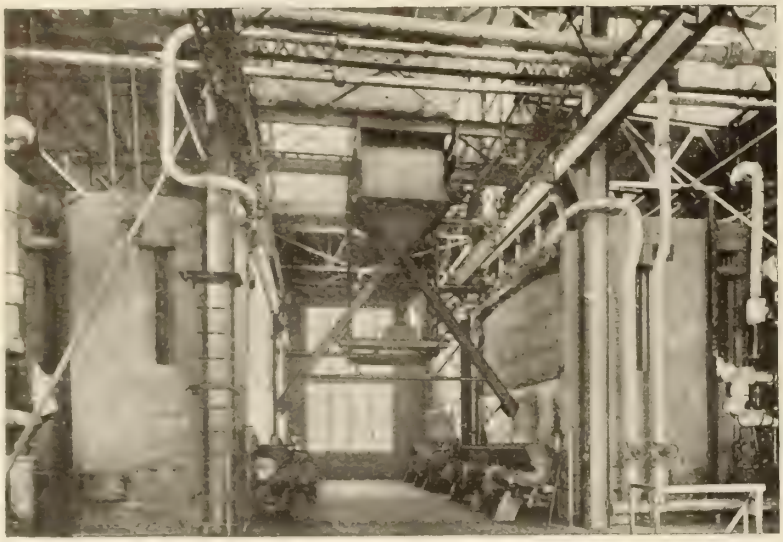
Heat Costs Money—Why Waste It?



These four 1050 h.p. boilers in the power plant of the Dominion Power & Transmission Company, Toronto, Ontario, are insulated with 45,000 Nonpareil Brick placed in the setting walls and over the steam drums.

Heat losses by conduction, radiation, etc., have for years been common to all power house plants. They have, in fact, been accepted as a sort of necessary evil.

Where comparatively high temperatures are employed the insulation material must be more than merely a good non-conductor. Fusing, shrinkage, convenience, structural strength, etc., are factors that must be considered.

NONPAREIL INSULATING BRICK

has, by actual experience, met these exacting requirements to a remarkable degree. It forms a permanent, built-in insulation; unaffected by jars, vibrations or by expansion and contraction. As for efficiency, by actual tests it has reduced by about two-thirds the heat loss by conduction and radiation. The saving in fuel alone will repay the cost of installation in a year or less.

The uses and advantages of insulation in brick form, are explained in the 72-page book, "Nonpareil Insulating Brick," which is sent free on request. Write for it.

ARMSTRONG CORK & INSULATING CO., LIMITED

503 McGill Bldg., MONTREAL 11 Brant St., TORONTO

SOME POINTERS ON BURNING WOOD FUEL

(Continued from page 40)

would cause the water to flow into No. 2 drum.

Of course the rate of flow undoubtedly will be proportioned to the boiler load.

The Effect

I may say the high water affected the plant in general causing a great deal of repairs through leaky joints, also glands on steam pumps and engines which needed constant attention.

We also noticed that when operating No. 3 boiler above normal rating our coal consumption per B. H. P. was extremely high, maximum being 4.7 lbs. per B. H. P. against No. 1 boiler operating at 70 per cent. efficiency or 36 lbs. per B. H. P.

I may go on to say in cases of this kind where engineers are troubled more or less with high and low water, especially when operating their boiler at a very high rating, it would be to their interest to examine the dry pipes thoroughly in order to determine whether or not the holes are partially plugged. Possibly the gasket may leak or the area of the pipes themselves may be somewhat different.

MORE WORK FOR HENRY WRIGHT

Mr. Henry Wright, A.M.E.I.C., chief engineer Montreal Street Railway, Hochelaga Power Plant and president of the Grand Lodge C.A.S.E., has been appointed instructor of the engineering classes at the Central Y.M.C.A., Montreal, for the season 1922-23. This, we know, will be a congenial task for the energetic Henry, who is never more happy than when helping the other fellow along.

C. A. S. E. MEMBER APPOINTED

Mr. J. H. Clarkson, St. Lambert, Montreal, has been appointed to the position of Chief Engineer of the new $8,000,000 Mount Royal Hotel, Peel Street, Montreal. Mr. Clarkson is well known in Montreal engineering circles, having been for some years chief engineer of the Central Y. M. C. A. in that city. Mr. Clarkson is an old member of the Canadian Association of Stationary Engineers and it is a pleasure to the members of his own branch in particular, and the association in general, that he should have received such an important appointment.

Waterville, N. S.—A pre-cooling plant of unique design is being installed in connection with the fruit storage warehouse by the Department of Agriculture. It consists of an ice tank with capacity of three tons, air ducts, gasoline engine and large insulated fan with capacity of 4,000 feet per minute. Air is forced through the ice tank in such a way as to ensure continuous circulation and even temperature.

BOILER INSPECTION CRITICISM

Editor, Power House,

Dear Sir:—

Does it not seem queer that in the banner province of the Dominion we have one of the poorest boiler inspection laws in the country, an act whereby anyone obtaining permission from the deputy minister in writing or holding an engineer's certificate of any class can inspect a boiler, and that inspection is accepted by the chief factory inspector.

Our western provinces have a law whereby no one without he holds a certificate as a boiler inspector can inspect a boiler, and that is the way it should be done, as it takes time to make an inspector.

Another thing, in Ontario the inspection of boilers is under two different departments, new boilers under the Boiler Inspection Department, and boilers in operation under the Factory Inspection Act.

It is about time that the engineers, in fact everyone connected with the operation of boilers, woke up to the fact that the inspection of boilers should be placed under one head so that a correct account of the boilers can be kept.

Now, Mr. Editor, I will not say any more but would like to hear what other engineers have to say.

L. J. E.

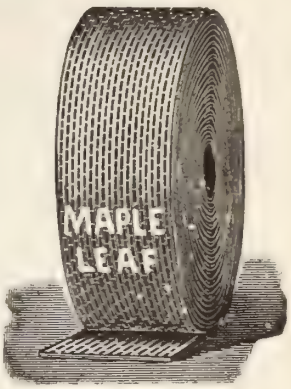
Dominion Belting Company, Limited

Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.

We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility

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NONPAREIL GRATES

Established 1900

A child can operate it

The Enemy of High Fuel Prices

Renewals and Repairs made for all kinds of Shaking and Dumping Grates.

ATTRACTIVE TRIAL OFFER

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We guarantee a saving of 10 per cent.
This is fair and reasonable—Why hesitate?

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Type "A" Grates and Tuyeres for Underfeed Stokers.

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Thos. Hays Corporation
CO_2 Recorder and Draft Gauge.

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Full information on all lines, upon application

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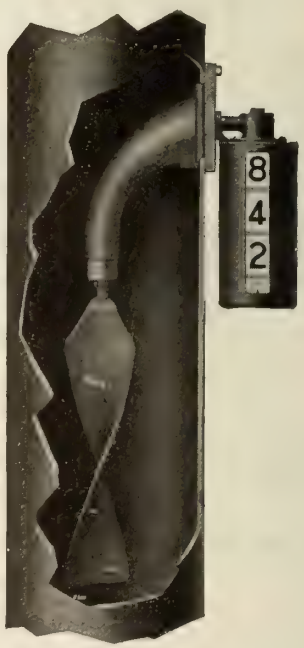
Domestic and Industrial Electric Heating Equipment.

GELINAS & PENNOCK REG'D.

207 St. James St. MONTREAL, CANADA

Nothing Complicated or Expensive About this Bailey Coal Meter



It is not necessary to install extremely expensive and complicated weighing apparatus above each coal chute to get the individual coal consumption of your boilers.

The Bailey Meter for Coal can be installed easily in existing coal chutes at a very moderate expense. No external power is required for its operation and, although built to withstand hard usage, it will give surprisingly accurate and consistent results with a minimum of attention.

The Vane is suspended from a ball bearing—dust proof and fully protected. The illuminated counter has figures 1½ inches high and may be read at a distance of 50 feet.

Write for Bulletin No. 220 which gives full description.

Bailey Meter Company Limited

177 Delorimier Ave., Montreal, Que.

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As superintendent or engineer, there can be no doubt that you have more than a "nodding" acquaintance with the products of the manufacturers listed here. Without exception they are lines that have established an International reputation for reliability—you'll appreciate that, too, from your own experience.

The popularity of these lines and the high standing of these manufacturers, whom we represent in Ontario, reflects our desire to handle only the most modern of high class Power Plant equipment.

In addition, we aim also to be of real service in coping with Canadian conditions and requirements. We maintain a staff of engineering specialists competent to advise on any unusual situation that may arise. Their service is free and without obligation.

How can we serve you?

The American Engineering Co., Philadelphia—Taylor Stokers.

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Coppus Engineering & Equipment Co., Worcester, Mass.—Turbo Blowers and Turbo Boilers, and Feed Pumps.

Coffin Valve Co., Neponset, Mass.—Sluice Gates.

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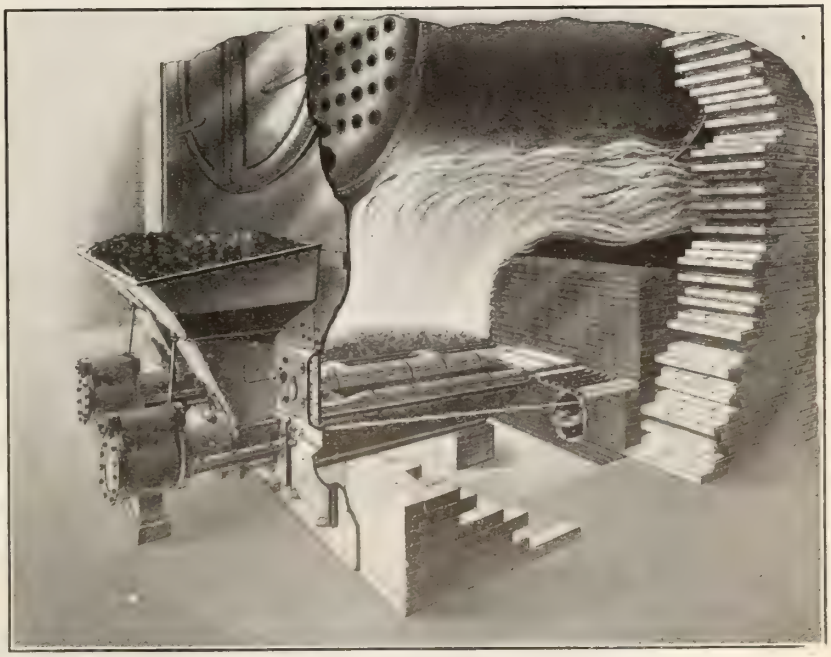

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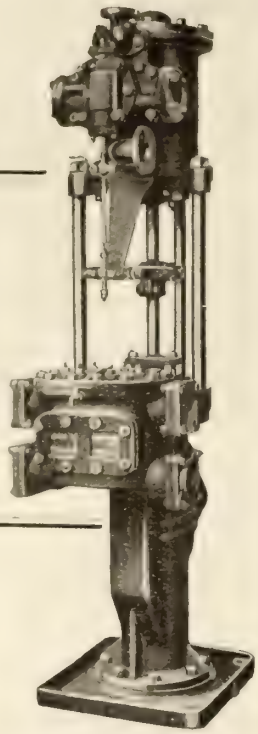

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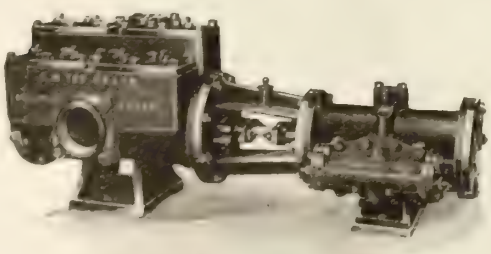

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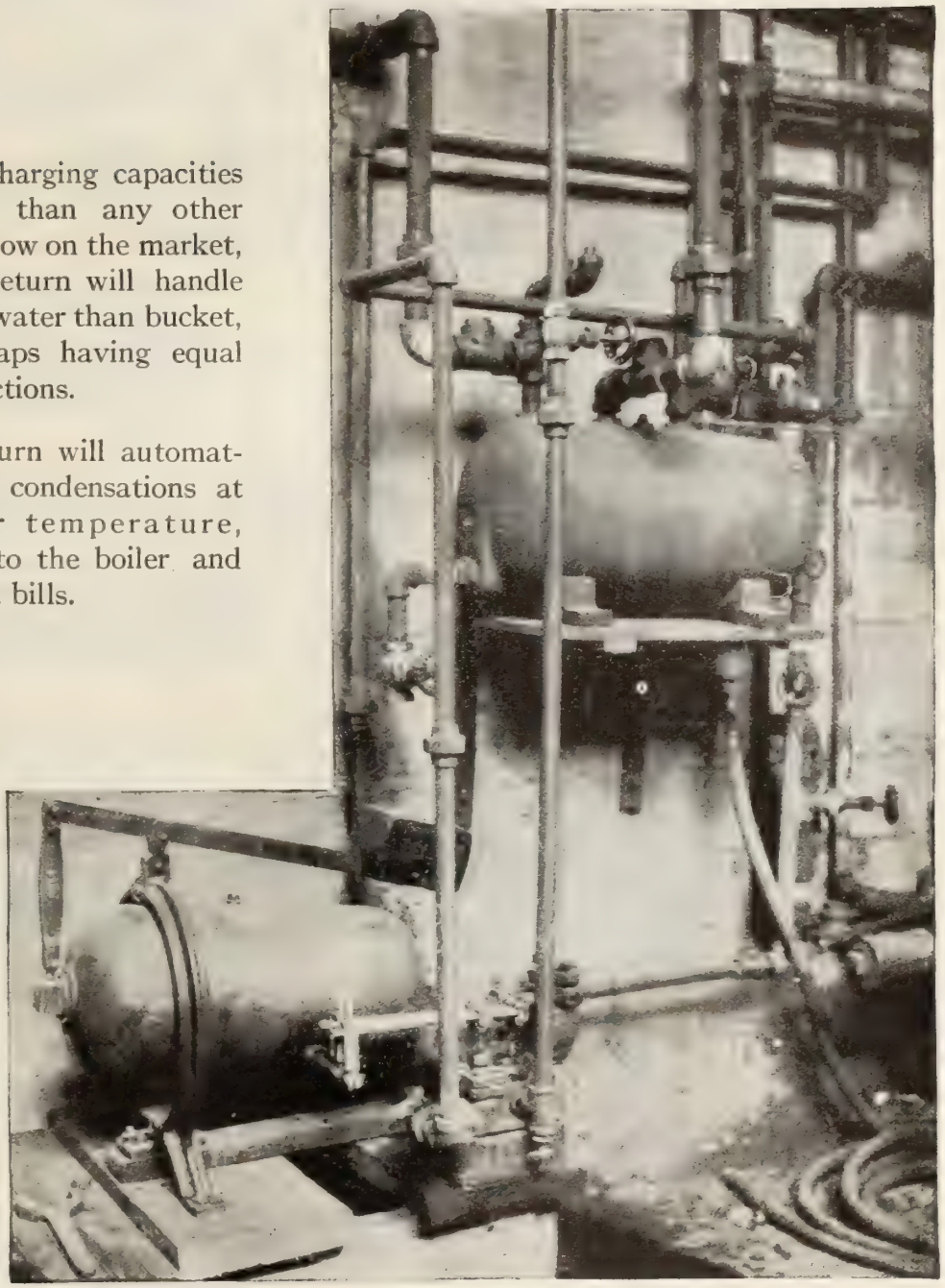

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—To impart information beneficial to the profession.

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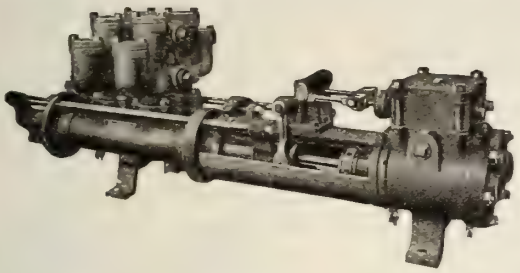

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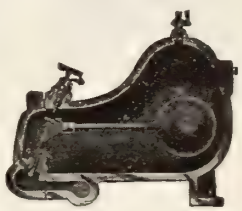

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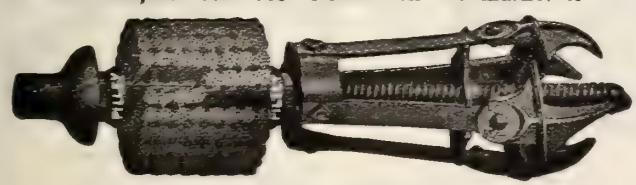

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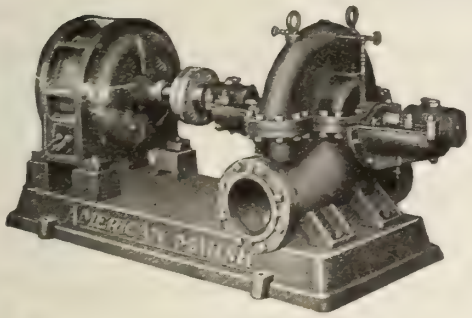

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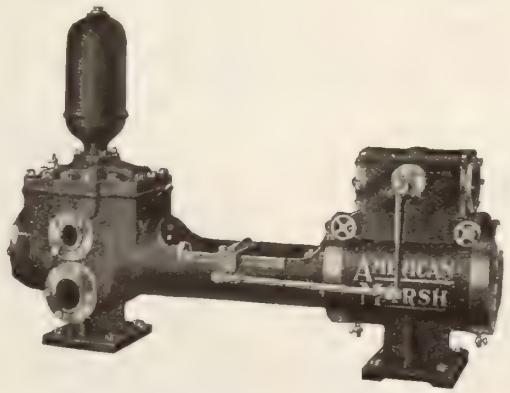

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Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland.
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

BOILERS, STEAM OR HOT WATER
Crane's Limited, Montreal.

BOILER SETTING CEMENT
Beveridge Supply Co. Ltd., Montreal, Que.
Jointless Fire Brick Co., Chicago, Ill.
Betson Plastic Fire Brick Co., Inc., Rome.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Engineering and Machine Works of Can. Ltd., St. Catharines, Ont.
The Underfeed Stoker Co. of Canada, Ltd., Toronto.
Ladd Co., The Geo. T., Pittsburgh, Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Leonard & Sons Ltd., E., London, Ont.
Engineering and Machine Works of Can., Ltd., St. Catharines, Ont.
Waterous Engine Works Co., Brantford

BOILER TUBE
W. R. Sexton Co., Toronto.

BOILER TUBE PROTECTORS
C. B. Turner, Toronto.

BOXES, FUSE AND METER
Johns-Pratt Co., The, Hartford, Conn.
Mueller Mfg. Co., Ltd., The.

BRASS BELLS
Mueller Mfg. Co., Ltd., The.

BRASS GOODS
Crane's Limited, Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., Ltd., The.
Penberthy Injector Co., Windsor, Ont.

BRASS FOUNDERS
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto
Kerr Engine Co., Walkerville, Ont.
Mueller Mfg. Co., H., Sarnia, Ont.
Penberthy Injector Co., Windsor, Ont.

BRASS PIPE AND TUBE
Crane's Limited, Montreal.
Mueller Mfg. Co., Ltd., The.

BRIDGES, MAN, TROLLEY AND ROPE OPERATED
Can. Mead-Morrison Co., Ltd., Montreal.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BUSHINGS
Can. Link-Belt Co., Toronto, Ont.

BUSHING BRONZE
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CALORIMETERS
Sarco Company, Inc., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Taylor Instrument Co., Toronto, Ont.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CARD CLOTHING
D. K. McLaren Limited, Montreal, Que

CANNERS' CONVEYORS
Can. Link-Belt Co., Toronto, Ont.

CASTINGS, ALLOY
Kerr Engine Co., Walkerville, Ont.
H. Mueller Mfg. Co., Ltd., Sarnia.

CASTINGS, BRASS AND IRON
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Kerr Engine Co., Walkerville, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Mueller Mfg. Co., H., Sarnia, Ont.
Victoria Foundry Co., Ltd., Oshawa.
Waterous Engine Works Co., Brantford.

CELLAR DRAINERS
Jas. Morrison Brass Mfg. Co., Toronto.
Mueller Mfg. Co., H., Sarnia, Ont.

CEMENT MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford.

CEMENT HANDLING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

CEMENT: HIGH TEMPERATURE
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
International Chemical Co., Toronto, Ont.
Jointless Fire Brick Co., Chicago, Ill.
Shell Bar Boico Supply Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

CHAINS, FOR ELEVATORS AND CONVEYORS
Can. Link-Belt Co., Toronto.

CHIMNEYS
Arthur S. Leitch Co., Toronto.

CLAMPS, MACHINISTS
J. H. Williams & Co., Brooklyn, N. Y.

CLEANERS, BOILER TUBE CLEANERS
The Vulcan Soot Cleaner Co., Du Bois, Pa.
Babcock & Wilcox, Ltd., Montreal.
Canadian Johns-Manville Co. Ltd., Toronto
Garlock Packing Co., Hamilton, Ont.
Goldie & McCulloch Co., Galt.
R. C. Miler Oil & Supply Co., Ltd., Montreal.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Yarnal-Waring Co., Philadelphia, Pa.

CLUTCHES
Can. Link-Belt Co., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford

CONVEYORS
Babcock & Wilcox Ltd., Montreal.
Can. Mead-Morrison, Montreal.
Godfrey Conveyor Co., Toronto.
Green Engineering Co., East Chicago, Ind.
Waterous Engine Works Co., Brantford.

COAL CRUSHERS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL HANDLING, MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.
Godfrey Conveyor Co., 106-110 Richmond St. West Toronto.
MacGovern & Co., Inc., Montreal, Que.
Northern Crane Works, Walkerville, Ont.
Mackinnon Steel Co., Ltd., Sherbrooke, Q.
Waterous Eng. Works Co., Brantford, Ont.

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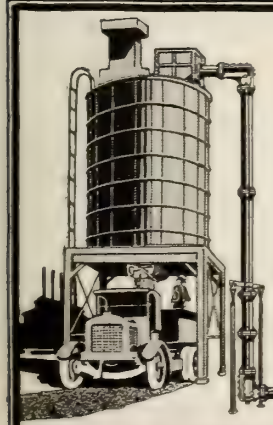

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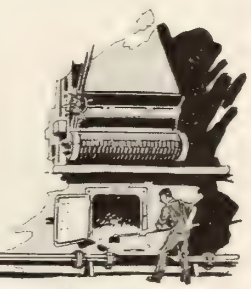

COAL POCKETS
Can. Mead-Morrison Co., Ltd., Montreal.

COAL SCREENING PLANTS
Can. Mead-Morrison Co., Ltd., Montreal.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal, Que.
The John H. McGowan & Co., Cincinnati, Ohio
Waterous Engine Works Co., Brantford.

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

CONDENSERS, DOUBLE PIPE
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

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Beveridge Supply Co., Montreal.

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CONNECTING RODS
J. H. Williams & Co., Brooklyn, N. Y.

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M. A. Kennedy, Ltd., Toronto.
Waterous Engine Works Co., Ltd., Brantford, Ont.
Can. Mead-Morrison Co., Ltd., Montreal.

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Jamieson Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insultaion Co., Montreal, Que.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont

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American Steam Gauge & Valve Mfg. Co., Boston, Mass
Schaffer & Budenberg Mfg Co., Brooklyn, N. Y.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Fairbanks-Morse Co. Ltd., Montreal

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
Goldie & McCulloch Co., Galt.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Mach., Co. Ltd., Hamilton.

CRANES, GANTRY
Can. Link-Belt Co., Toronto.
Northern Crane Works, Walkerville, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Frick Co., Waynesboro, Franklin Co., Pa.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, LOCOMOTIVE
Canadian Link-Belt Co., Toronto
Northern Crane Works, Walkerville

CRANES, OVERHEAD TRAVELING
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Boving Hydraulic & Eng., Co., Ltd., Lindsay, Ont.
Can. Link-Belt Co., Toronto, Ont.
Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.
Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Babcock Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK SHAFT
J. H. Williams & Co., Brooklyn, N.Y.

CRUSHING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal.

DIESEL ENGINES
Laurie & Lamb, Montreal.

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Gutta Percha & Rubber Co., Ltd.

DIAPHRAGM RELIEF VALVES
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

DISCS, FIBRE
Johns-Pratt Co., The, Hartford, Conn.

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Mason Regulator & Eng. Co., Ltd., The, Montreal.
Frick Co., Waynesboro, Franklin, Co., Pa.
York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

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Jamieson Cold Storage Door Co., Hagerstown, Md.

DRAFT GAUGES
Schaffer & Budenburg Mfg. Co., Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP- FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.

EJECTORS
Jas. Morrison Brass Mfg., Co., Toronto
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Windsor, Ont.

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Canadian Johns-Manville Co., Ltd., Toronto.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Gelinas & Pennock, Reg'd, Montreal.

ELECTRICAL SUPPLIES
Canadian Johns-Manville Co., Ltd., Toronto, Ont.

ELECTRIC MOTORS
Gelinas & Pennock, Reg'd, Montreal
B. F. Sturtevant Co., Boston, Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
MacKinnon Steel Co., Ltd., Sherbroke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Darling Brothers, Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co., of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg., Co., Toronto.
H. Moeller Mfg. Co., Limited, Sarnia, Ont.

ENGINE INDICATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Dominion Steel Products Co., Ltd., Brantford, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont

ENGINES, GASOLINE STATIONARY
Sterling Engine Co., Buffalo, N. Y.
Leonard & Sons, Ltd., E. London, Ont.

ENGINES: GASOLINE FOR PUMP AND EMERGENCY GENERATOR, DRIVES
Sterling Engine Co., Buffalo, N.Y.
Leonard & Sons, Ltd., E., London, Ont.

ENGINES, STEAM
Canadian Sirocco Co., Ltd., Windsor, Ont.
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F., Toronto, Can.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.

ENGINES, SAW MILL
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Prantford.
Sturtevant Co., B. F., Toronto, Can.

ENGINES, VERTICAL
Canadian Sirocco Co., Ltd., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
Leonard & Sons, Ltd., E., London, Ont.
Sturtevant Co., B. F. Toronto, Can.

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Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

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Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

EXPANSION JOINTS
Direct Separator Co., Syracuse, N. Y.
Jas. Morrison Brass Mfg. Co., Toronto.
Lunkenheimer Co., Cincinnati, Ohio.

EXPANSION BOLTS
Beveridge Supply Co., Montreal.
Williams & Co., J. H., Brooklyn, N.Y.

EYE BOLTS

FANS, VENTILATING
Canadian Sirocco Co., Ltd., Windsor, Ont.
Sturtevant Co., B. F. Toronto, Can.

FAN ENGINE REGULATORS
Under-feed Stoker Co., of Canada, Ltd. Toronto, Ont.

FEED WATER HEATERS
Mason Regulator & Eng. Co., Ltd., The, Montreal.
Babcock & Wilcox, Ltd., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Arthur S. Leitch Co., Ltd., Toronto.
Leonard & Sons, Ltd., E., London, Ont.
Pratt & Cady Co., Inc., Hartford, Conn.
Waterous Engine Works Co., Brantford.
Northern Equipment Co., Toronto.

FEED WATER METERS
Bailey Meter Co., Limited, Montreal.

FEED WATER PURIFIERS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.
Yarnell-Waring Co., Philadelphia, Pa.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Laurie & Lamb, Montreal.

FILTERS
Graver Corp., East Chicago, Ind.
Laurie & Lamb, Montreal.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FILTERS, WATER
Mason Regulator & Eng. Co., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Graver Corp., East Chicago, Ind.
American Steam Gauge & Valve Mfg., Co., Boston, Mass.
Scaife & Sons, Wm. B., Pittsburgh, Pa
York Mfg. Co., York, Pa.

FILTERING AND CIRCULATION SYSTEMS
Graver Corp., East Chicago, Ind.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FIRE BRICK
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK MORTAR
Beveridge Supply Co., Montreal .
Boston Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Co., Toronto.

FIRE BRICK CEMENT
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Beveridge Supply Co., Montreal.
Jointless Fire Brick Co., Chicago, Ill.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamieson Cold Storage Door Co., Hagerstown, Md.

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FITTINGS, AIR, AUTOMOBILE, GAS, HYRDAULIC, PIPE FLANGED, SCREWED PIPE, STEAM
Crane Limited, Montreal.

FITTINGS
Crane Limited, Montreal.

FITTINGS, CAST IRON
Crane Limited, Montreal.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.

FITTINGS, DRAINAGE
Crane Limited, Montreal.

FITTINGS, MARINE
Jas. Morrison Brass Mfg., Toronto.

FLANGED STEAM FITTING
Crane Limited, Montreal.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
Kerr Engine Co., Walkerville, Ont.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Kerr Engine Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Page-Hersey Tubes, Ltd., Toronto, Ont.

FLOOR AND CEILING PLATES
Crane's Limited Montreal.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.
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Bailey Meter Co., Limited, Montreal.
Bailey Meter Co.
Dominion Flow Meter Co., Toronto.
Mason Regulator & Engineering Co., Ltd., Montreal.
Yarnall-Waring, Philadelphia, Pa.

FLUE GAS COLLECTORS
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Metaer Co., Toronto.

FLUE CLEANERS
Shell Bar Boico Supply, Ltd., Toronto.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Wm. B. Scaife & Sons, Pittsburg, Pa.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FUEL AND OIL PUMPS AND MEASURING SYSTEMS
Imperial Oil, Ltd., Toronto.

FURNACES
Under-feed Stoker Co. of Canada, Ltd., Toronto.

FURNACE LINING
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.

FURNACE DOOR ARCH
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Jointless Fire Brick Co., Chicago, Ill.

FUSES
Canadian Johns-Manville Co. Ltd., Toronto
Johns-Pratt Co., The, Hartford, Conn.

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Penberthy Injector Co., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Dominion Flow Meter Co., Toronto.

GAS METERS
Bailey Meter Co., Limited, Montreal.

GASKETS, MANHOLE AND HANDHOLE
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, RUBBER, ASBESTOS
Shell Bar Boico Supply, Ltd., Toronto.
Peldam Asbestos (Canada) Co., Toronto.
Canadian JohnsManville Co. Ltd., Toronto
Can. Steam Boiler Equip. Co., Toronto
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton. Ont.

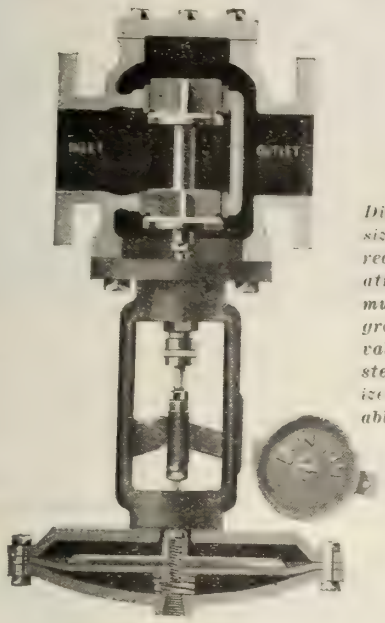
GASKETS, COMPRESSED ASBESTOS SHEETS
Canadian Raybestos Co., Ltd., Peterborough, Ont.

GASKETS, LEAD, COPPER AND LEATHER
Shell Bar Boico Supply Co., Toronto
Sarco Inc., New York, N.Y.

GAS ANALYSIS CO-2
Dominion Flow Meter Co., Toronto.

The DUNHAM
REG TRADE-MARK
HEATING SERVICE
(Made in Canada)

Reducing Pressure Valves
Straight Pattern — Sectional View



Diaphragms of various sizes are furnished for reduced pressures, with atmosphere as minimum. Castings of best grey iron. Seats and valves of non-corrosive steam metal. Standardized and interchangeable parts.

Steam, Water, Air Pressure Control

The Dunham Reducing Pressure Valve automatically reduces steam, water, or air from an initial high pressure to any lower delivery pressure. It affords adjustable control that secures an accurately fixed and noiseless low pressure delivery no matter how much the high pressure side of the valve might vary.

Dunham Reducing Pressure Valves are made in both Straight and Expanded Outlet types. They are scientifically designed and built of the finest selected materials to insure dependable and lasting service.

Complete data on request.

C. A. DUNHAM Co., Ltd.

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HALIFAX VANCOUVER WINNIPEG OTTAWA MONTREAL CALGARY

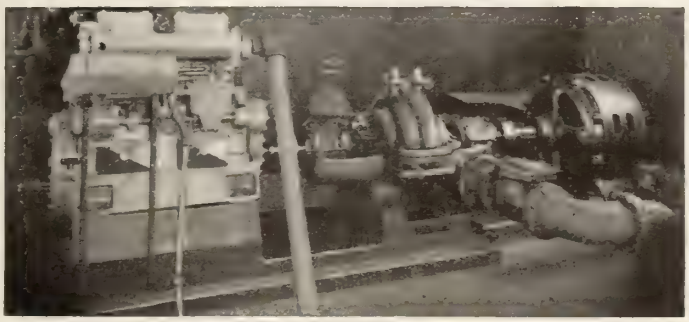
London, Eng., 18 St. Thomas St., S.E.1.

Also manufacturers of a popular line of heating specialties.

Sterling

Vs. MAXIMUM DEMAND

Analyze your power costs—it will pay you to use STERLING engines. With a STERLING engine to carry peak loads you can purchase power at the minimum rate, run your STERLING when the peak comes on, and have an efficient standby unit, ready instantly. Based on the average difference between the central station minimum power rate and the charge for demand service, a STERLING driven pump or generator set would probably pay for itself within two years.



Model GRC 4 cylinder 150 H.P. STERLING direct connected to 6″ 2 stage De Laval centrifugal delivering 1,050 G.P.M. against 260 ft. head at 1,200 R.P.M. Reserve pump installed at Seneca Falls, N.Y., by Power Equipment Co. of Boston.

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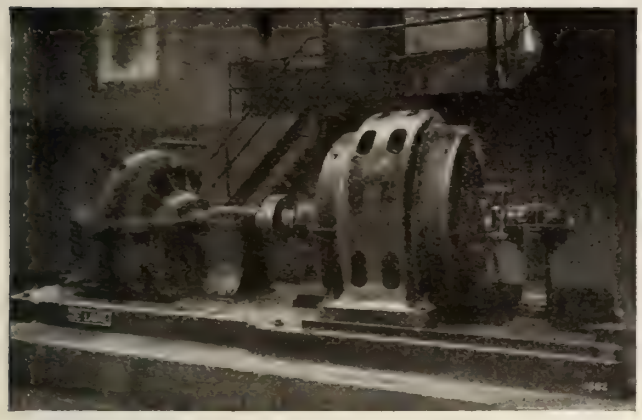
DeLaval Pump at Montreal Shows Over 86% Efficiency



TO TAKE advantage of the low cost of hydro-electric power the engineers of the City of Montreal some two years ago issued specifications for motor driven centrifugal pumps to deliver 30,000,000 Imperial gallons per 24 hours against 200 ft. total head. An official test made recently on a De Laval pump installed in 1920 gave the following results:

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33,294,000	27,745	215.35	93.9	85.2
32,554,000	27,128	221.33	93.9	86.36
31,660,000	26,383	225.43	93.9	86.44
30,294,000	25,245	229.92	93.9	85.5

The high efficiency attained by this De Laval centrifugal pump is due to refinements of design developed and made possible through many years of experience in building high grade centrifugal pumps. The great amount of pioneer and continued experimental work carried on by the De Laval engineers has enabled them to determine the influence of all modifications in design and to proceed progressively to better and better results. High efficiency is also due in part to extremely accurate and high class workmanship. Accurate construction of parts and absolute interchangeability is insured by the use of limit gages in production and rigid inspection of the parts during the course of manufacture.

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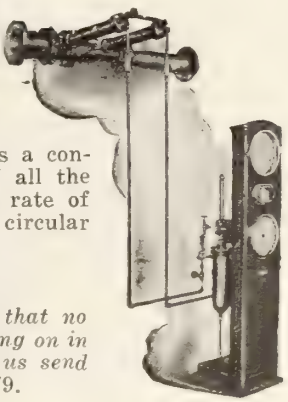

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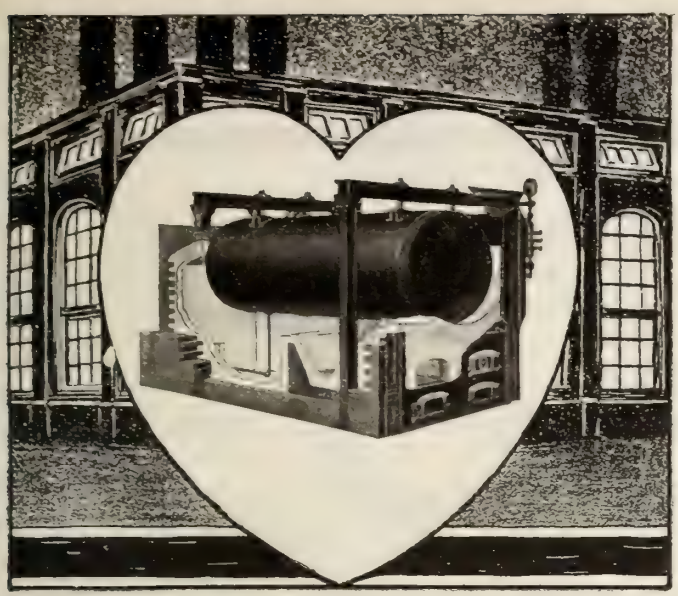

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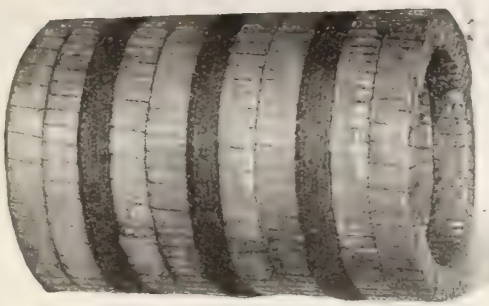

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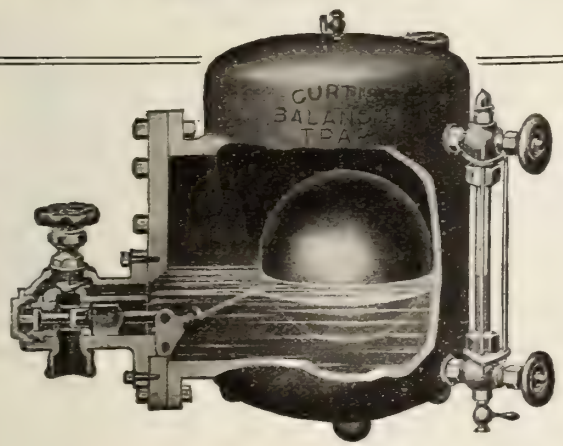

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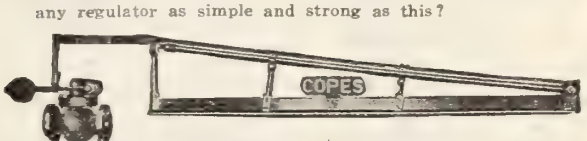

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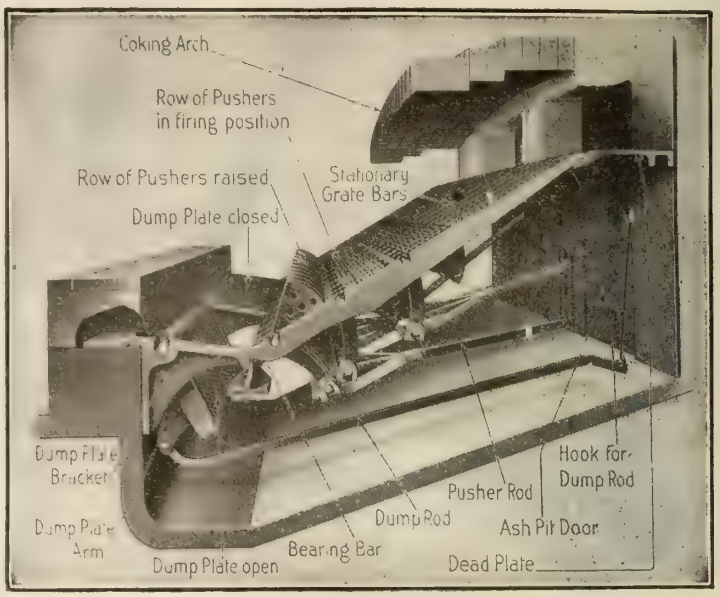

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WATER

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ALL INDUSTRIAL USES

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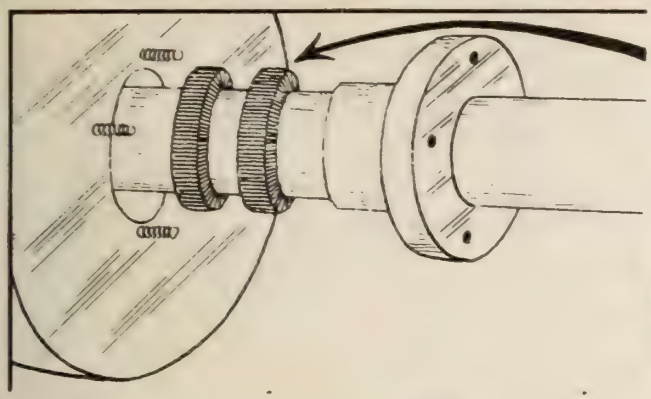

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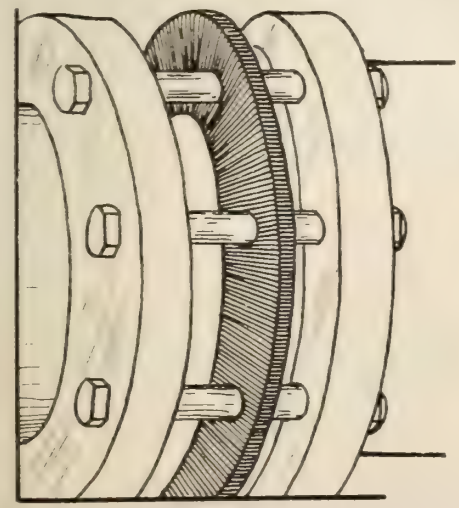
"They Wear Longer."

The Engineer Wants Raybestos Packings because he knows they are Heat-proof and Acid-resisting.

Use Raybestos Packings for Pipe Flanges, Cylinder Heads, Piston Rods, Valve Stems, Plungers, Boiler Manhole and Handhole Plates—and all packings for Air, Steam, Acid, Oil or Ammonia.

The consistent use of Raybestos Packings will result in substantial economy—"They Wear Longer."

The Canadian Raybestos Co., Limited
PETERBOROUGH, ONTARIO



Raybestos

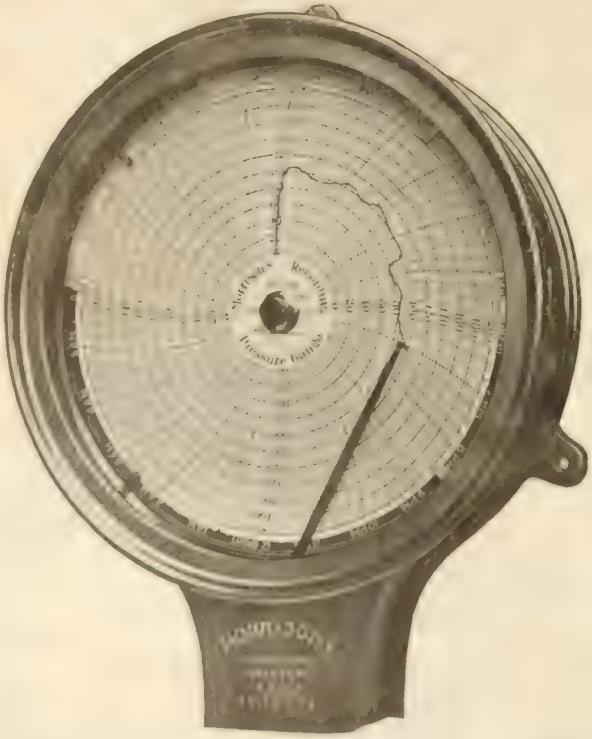
Pipe Flange Gaskets

From Raybestos Jointing—Ready for any emergency

MORRISON

PRESSURE RECORDING GAUGES

Don't waste your fuel



MORRISON Pressure Recording Gauges effectively remove the worries of "trying to keep track" from the shoulders of the busy executive by giving him continuous records of steam pressure—records which tell him at a glance whether he is getting maintained pressure without unnecessary fuel loss.

Wherever installed they are considered indispensable alike to the plant executive as a simplified form of cost accounting, and to the fireman as a guidance to economical firing.

By specifying "Morrison's" you are sure of a Recording Pressure Gauge that can be depended upon for unvarying accuracy and long life under all conditions.

"Every Installation is a Demonstration of Merit"

The James Morrison Brass Mfg. Company Limited

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POWER HOUSE

A semi-monthly paper devoted to the Generation, Transmission, and Application of Steam, Gas, Electric, Air and Water Power; the operation of Refrigerating Machinery; Heating and Ventilating Equipment.

Published by The MacLean Publishing Company, Limited, 143-153 University Avenue, Toronto

MONTREAL, WINNIPEG, VANCOUVER — LONDON, ENG.: 88 Fleet Street, E.C. — NEW YORK, BOSTON, CHICAGO

Vol. XV.—No. 21 — Publication Office, Toronto—November 5, 1922 — Published Semi-Monthly Canada, $2; U.S. $2.50 a year

Sexton Says —

"I guarantee to reduce your fuel expenses by at least 10%"

WM. RUSSELL SEXTON
Member—C. A. S. E.

"Burn All"

A Child Can Operate It

There's No Better Time than the Present

It will pay you to see **"Safety First" Sexton** for all your **Firebrick Work** —building-in boilers and general repairs. Sexton has gained a reputation for doing his work with rare efficiency. His work lasts longest and many of the largest plants in Canada are ready to back up this statement.

This saving of 10% of fuel expenses isn't theory, it's an absolute fact. Some of the largest Canadian manufacturers had their experts investigate our claim and on the report of these experts they installed

NONPAREIL GRATES

They are now getting maximum heat from every pound of fuel—low grade fuel at that—because the 65% air space and 95% underdraft of NONPAREIL Shaking and Dumping Grates ensure complete combustion without waste.

You are at liberty to test the NONPAREIL under any kind of boiler for 30 days—no obligation. **There never will be a better time than the present.**

AGENTS: Gates Engineering Co., Montreal, Que. Mr. C. Berry, Ottawa, Ont. Mr. A. McTaggart, Leamington, Ont.

— Manufactured Solely By —

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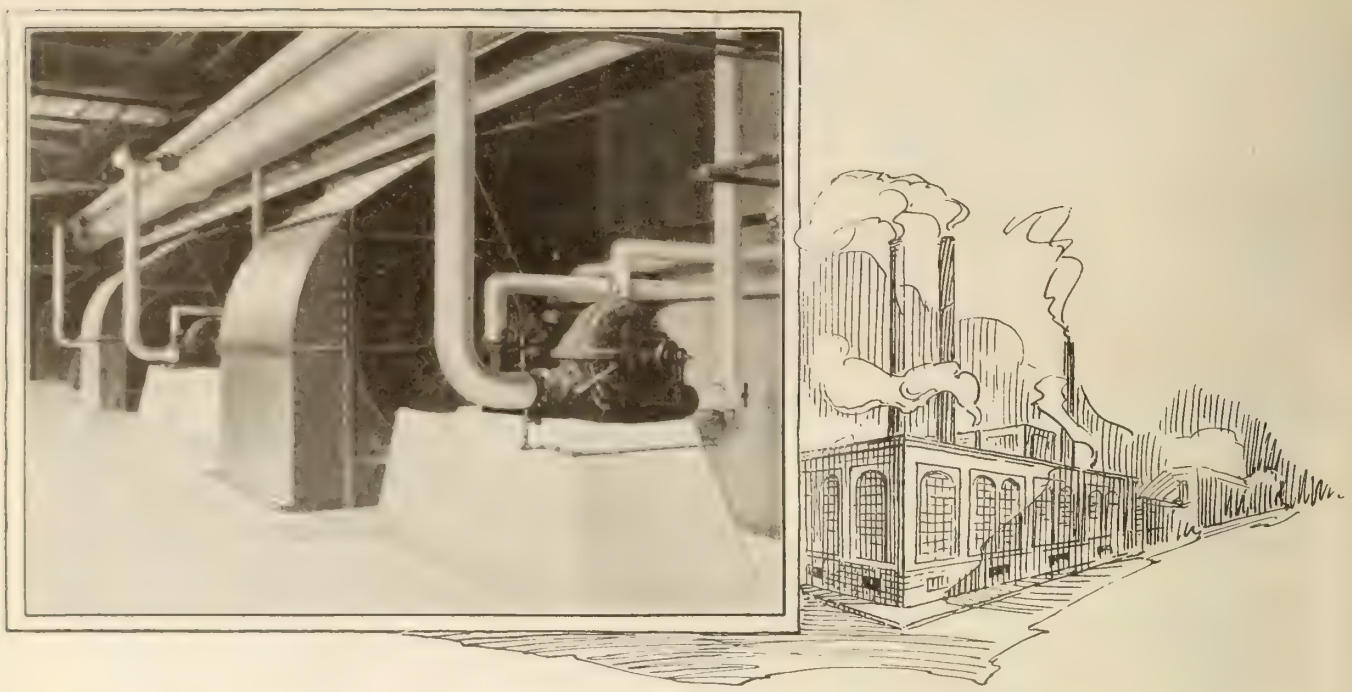
114 Grenadier Road — TORONTO

ESTABLISHED 1900—Phone Junction 2765W.

Renewals and Repairs for all kinds of Shaking and Dumping Grates for all sizes of Boilers.

Our PINHOLE GRATE burns—anything. — Special Bars for Brickyards.



Reduce Your Power Costs With "Sirocco" Products for Mechanical Draft

Only through the use of mechanical draft and stokers is it possible to maintain the high rates of combustion necessary to carry the peak loads in modern power plants. The blower is the most important auxiliary upon which the uninterrupted and efficient operation of the boiler plant depends.

The blower, best suited for any mechanical draft installation, depends upon many factors—the kind of fuel, the boiler rating, the type of stoking, the method of drive, whether electric or steam, and numerous others. The blower is just as necessary to the power plant as lungs are to the human body.

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"Sirocco" Fans are so built that dependable, never-failing service is a certainty. "Sirocco" Products afford a selection of apparatus to most efficiently meet any condition.

Our engineers will be glad to make recommendations covering your particular requirements.

CANADIAN SIROCCO COMPANY, LIMITED, WINDSOR, ONTARIO
BRANCHES IN ALL PRINCIPAL CITIES

96

"Sirocco" Products

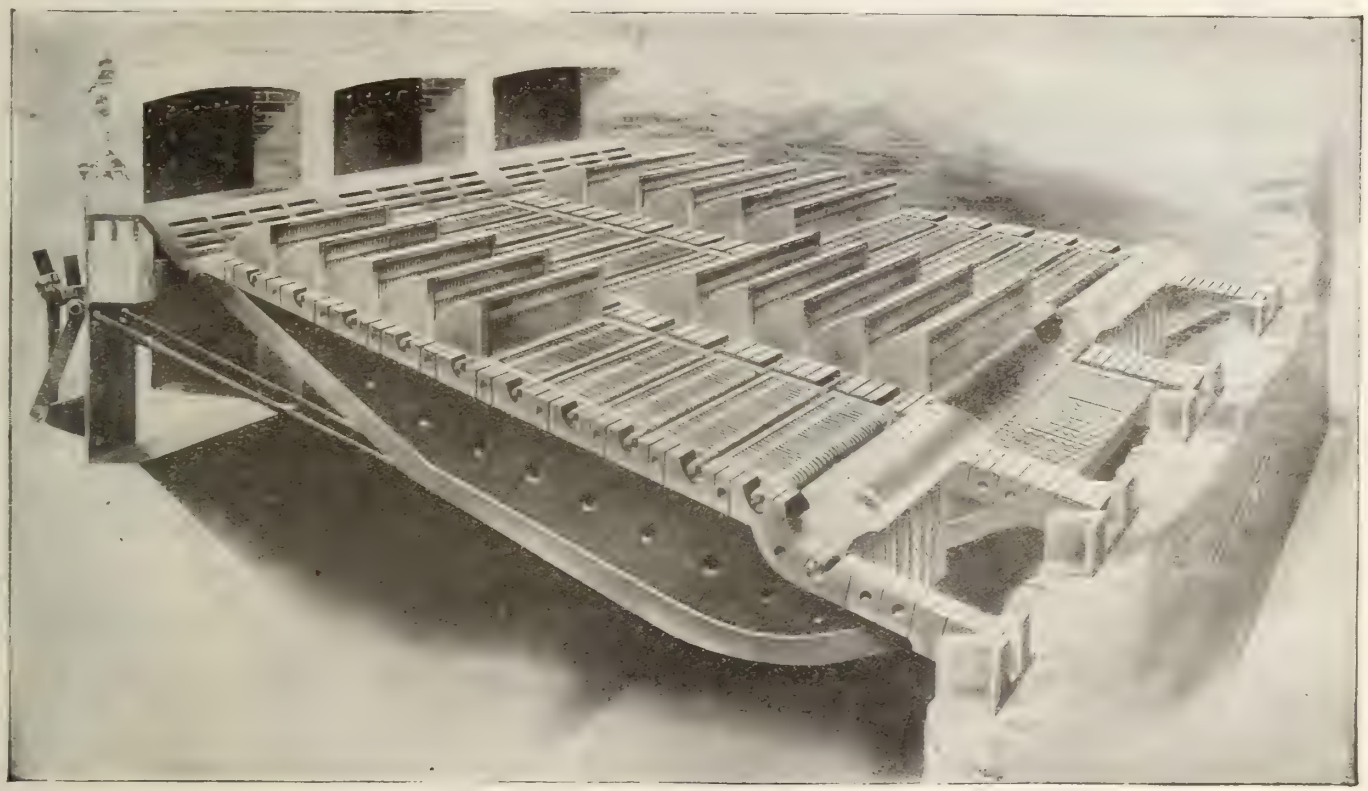
TRADE MARK

BLOWERS · EXHAUSTERS · VENTILATING FANS · AIR WASHERS · ENGINES

FOR HEATING, VENTILATING, DRYING, AIR CONDITIONING, MECHANICAL DRAFT

Files Stokers

Hand Operated



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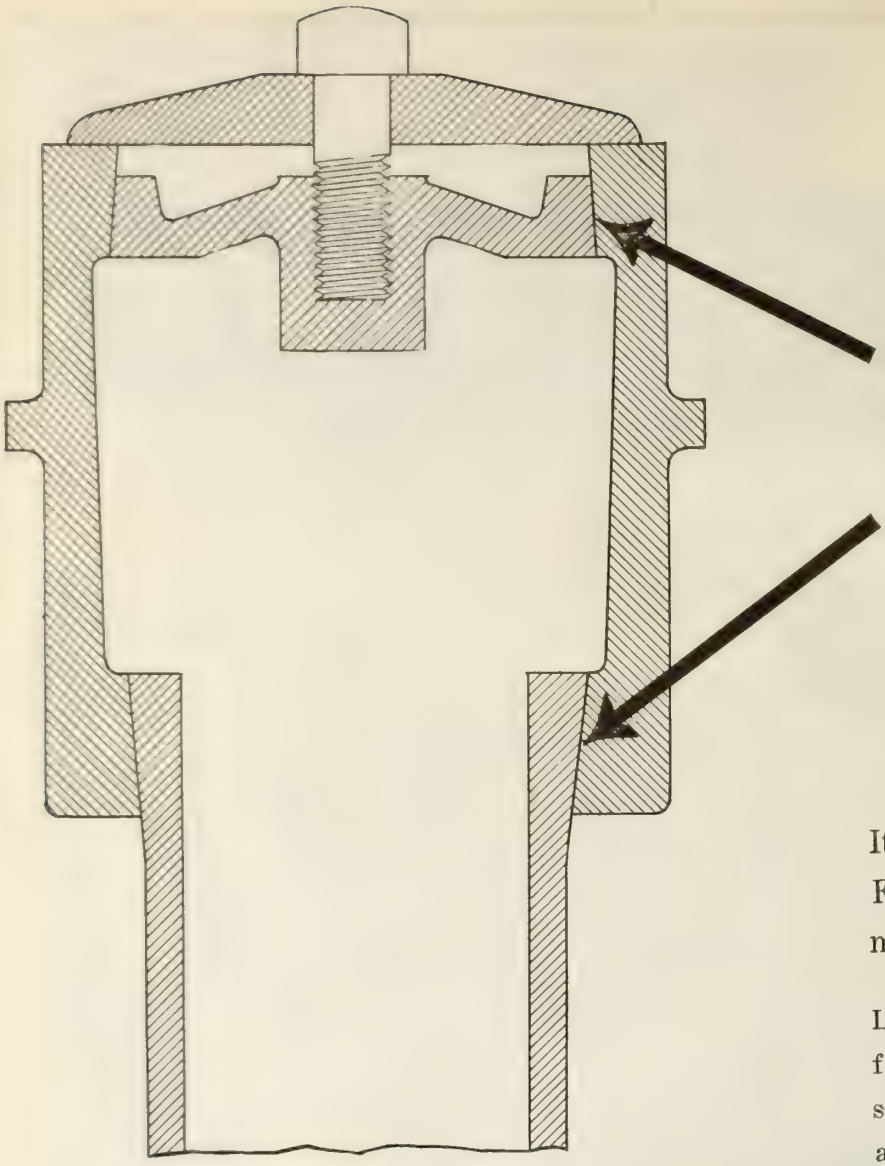
BRANTFORD, ONTARIO, CANADA



Diagrammatic view of a Sturtevant Economizer Head

See Those Tapers

It is right there where the Sturtevant Fuel Economizer shows one of its many points of superiority.

Look at the illustration and you will see for yourself that the greater the pressure the tighter becomes the tube and also the header, because of the tapers.

These parts are machined so that the fit is as accurate as human skill can make it. No rust joints, no cement, no packing, just a real metal-to-metal joint.

Should repairs ever be necessary, the cap is removed, draw-out rods with wedges are inserted, and the pipe started from its tapered friction joint. A new pipe, exactly the same as the one removed, is then put in and made tight again by hammering into contact—the tapered joints,metal-to-metal fit—tight.

Send for information on Sturtevant metal-to-metal joint Economizers, installed in high-pressure power plants.

B. F. STURTEVANT COMPANY OF CANADA, LIMITED

TORONTO GALT MONTREAL

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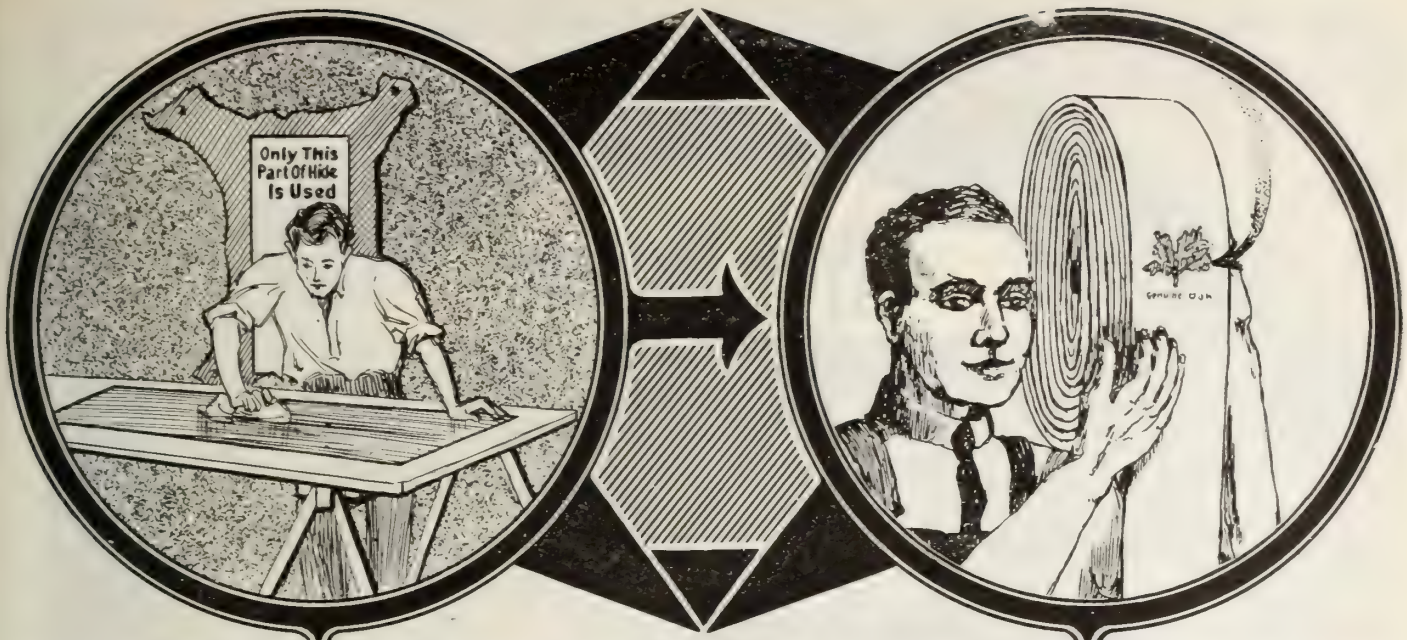

From Currying to the Finished Belt

Every Operation in the Manufacture of

D. K. McLaren's GENUINE BRITISH OAK TANNED Leather Belting

is handled by experts. Every hide used is selected with discrimination from those of the choicest steers. These are closely trimmed of all shoulders, necks and bellies and **only the tough back portions are used.** These, in turn, are subjected to the

Genuine British Oak Tanning Process

This class of tannage should not be confused with the ordinary sole leather tannage of Hemlock, commonly used by belt makers and called "Oak." The British Oak Tanning is a long-time process, not generally used because it is considered too expensive. It is to this tanning process, however, that D. K. McLaren's Leather Belting owes its reputation for that "gripping power" which means real "service on the pulley." Even under adverse conditions its remarkable stretchless quality and flexibility are an assurance of efficiency that leaves the power house engineer "worry-free."

The Oak Leaf is stamped on all D. K. McLaren's Belting as the sign of this efficiency —look for it.

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A CAREFULLY proportioned radius and tangent of a pipe bend will frequently relieve the entire system of expansion strains; reduce leakage at the joints; and eliminate upkeep cost.

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13a

TRADE MARK
"PALMETTO"
REG U S PAT OFFICE
may not be cheaper than many other rod packings, but it certainly gives much longer service even under extreme conditions.
After all—it's the length of service that really determines the value of a packing.
Let us send you working samples of both forms, so that you may try it out—no charge.
BRAIDED for rods.
TWIST for small valves.
Greene, Tweed & Co.
Sole Manufacturers
109 Duane St., New York
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The Canadian Fairbanks-Morse Co., Limited, Montreal, Ottawa, St. John, Toronto, Winnipeg, Calgary, Saskatoon, Victoria, Vancouver.
PALMETTO

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

"P M S"

The Belting That Made Good!

These reliable and highly efficient belts pay for themselves quickly, in power saved by better transmission and in extra sales and revenue from continuous production. With "P M S" Belts installed, workmen are continually employed and machines run full time without interruption for belt repairs and adjustments.

Red Ribbon "P M S" Belting

If your belting must work under difficulties in the character of the drive, or meet severe effects of heat, cold or moisture, "P M S" is the belting for you.

MADE EXCLUSIVELY BY

Gutta Percha & Rubber, Limited

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Maintenance cost is low

LUNKENHEIMER REGRINDING VALVES

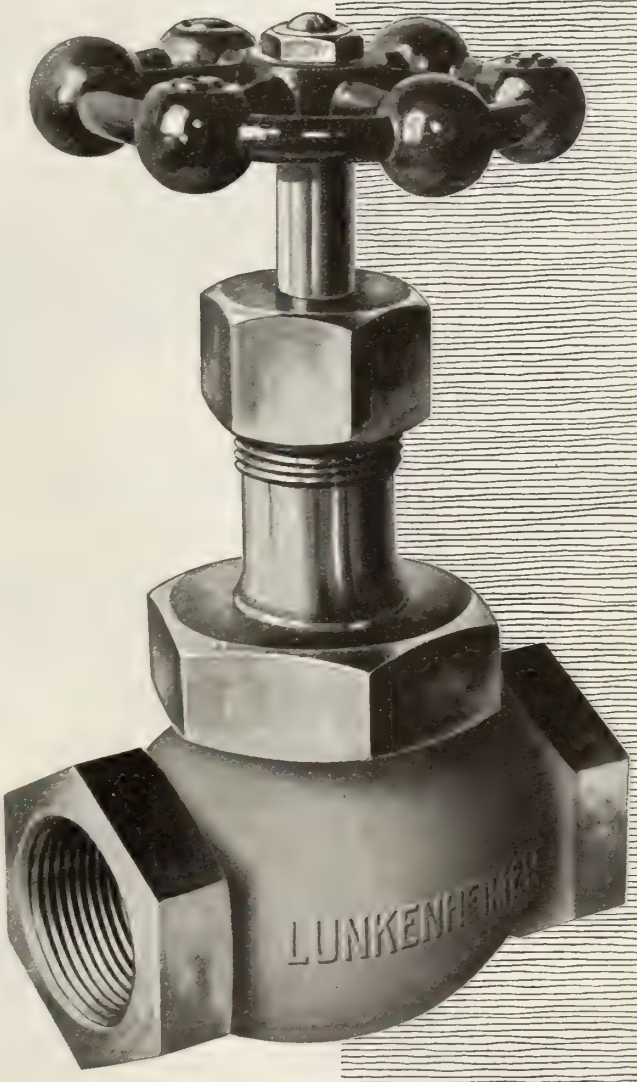
have proved this true by the results they have given in every class of service, extending ever a period of half a century.

The success of Lunkenheimer Regrinding Valves is determined and made certain by the Lunkenheimer method of manufacture, which provides a special bronze composition for each part, depending on the function the part performs, making the valves as near wear-proof as can be attained. Sincere workmanship together with rigid tests and inspection are further assurance of satisfactory service to the user.

The regrinding seating surfaces provide ready means for effecting repairs when necessary and at small cost.

Globe, Angle and Cross Valves and Horizontal, Angle, Vertical and Swing Check Valves for pressures up to 200 and 300 pounds.

Booklet 517-DC lists and describes the entire line. Shall we send you a copy?



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"America's Best since 1862"

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO CINCINNATI, U.S.A. BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

3-25-43.

THIS CONCRETE DAM

successfully met a severe test

CANADA is justly proud of her "white coal." The development of the Dominion's water power has employed the highest skill of the engineering profession—and in this development concrete and reinforced concrete construction have played an important part—both as regards publicly-owned and privately-owned water rights.

Our illustrations are from photos of the Southern Canada Power Company's plant at Drummondville, Quebec.

The top view shows the completed dam—and the arrow points to the location of the Power House.

The lower view illustrates the splendid resisting qualities of concrete. The breaking up of the ice nine days before the completion of the work unexpectedly flooded the dam; yet the structure was uninjured by the severe strain thus suddenly placed upon it.

CANADA CEMENT COMPANY LIMITED

Canada Cement Company Building

Phillips Square - MONTREAL

Sales Offices : Montreal Toronto Winnipeg Calgary

Specify
CANADA CEMENT
Uniformly Reliable

CANADA CEMENT CONCRETE FOR PERMANENCE

Our Service Department is anxious to co-operate in all lines of work for which Concrete is adapted. Our library is at your disposal [illegible]

You can hit it with a hammer—

Is this a foolish test?

CERTAINLY you would not test pipe covering for thermal value with a hammer.

But if a pipe covering that shows the greatest thermal value or efficiency, will also withstand the hard blows of a hammer it will surely resist the hard wear and tear frequently encountered in certain parts of the plant and factory.

Impartial tests have repeatedly shown Johns-Manville Asbesto-Sponge Felted Insulation the most efficient commercial insulation on the market. Its remarkable strength assures you that this efficiency will be maintained indefinitely.

If initial efficiency is the only quality you are interested in, the hammer test is absurd. If you are interested in the life of this efficiency and the durability of a pipe covering under severe conditions the test does tell a story.

CANADIAN JOHNS-MANVILLE CO., LIMITED
Toronto Montreal Winnipeg Vancouver Windsor Ottawa

Through—
Asbestos
and its allied products
INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials

LINDE

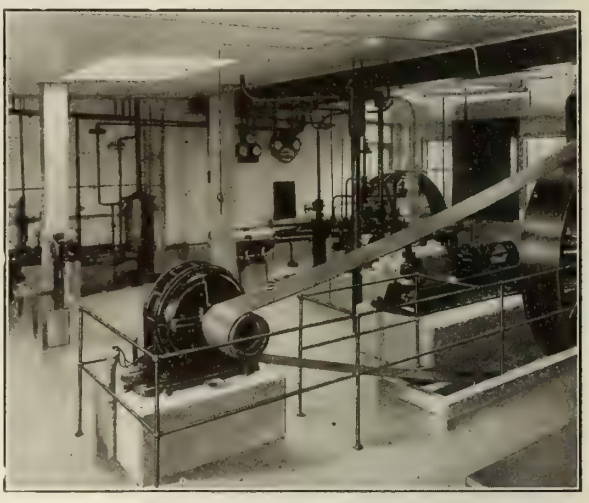
Made in Canada

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

Jamison HEAVY DUTY

Cold Storage Doors

Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.

(Formerly Jones Cold Store Co.)

HAGERSTOWN MARYLAND, U.S.A.

A shipment of Nonpareil Corkboard used in insulating the plant of the Atlantic Ice and Coal Corporation, Atlanta, Ga.

Clean-cut and Uniform

IN THE carload, as in the sample, Nonpareil Corkboard shows the high quality that has made it the standard cold storage insulation. You can depend on that quality no matter how much or how little you get.

The even color means that the boards are uniformly baked and, hence, are uniform in insulating value and structural strength. And notice the edges, how clean and straight they are. Nonpareil Corkboard does not have to be wasted by trimming out defects or crooked edges. Take them as they come; there are no "rejects" in Nonpareil Corkboard.

Clean-cut, uniform Nonpareil Corkboards can be handled more quickly and, therefore, erected at less cost than defective boards that have to be sorted and trimmed. They set up true and close and make a tight job with no "pockets" or open joints to collect moisture or frost.

Quality in a sample is one thing. Quality in the car load is quite another. You are assured of both with Nonpareil Corkboard.

Before Planning your new rooms get a copy of "Nonpareil Corkboard Insulation," a 152-page book of insulation facts that will help as well as interest you. Sent free on request with a sample.

Armstrong Cork & Insulation Co., Ltd.

902 McGill Bldg., **Montreal, Que., Can.**

11 Brant Street, **Toronto, Ont., Can.**

Also manufacturers of Nonpareil Cork Covering for brine and ammonia lines, coolers, tanks and cold surfaces generally; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Cork Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

"For Reliable Service give me YORK Equipment"

When the Operating Engineer of an Ice Making or Refrigerating Plant insists upon the Plant Manager buying York Ammonia Fittings and Supplies, he knows he is saving himself a lot of time and trouble and also reducing the operating costs of the plant.

He knows, because he has learned through past experiences of his own, or perhaps from another Engineer, that York Equipment is designed and made to meet the severest Service.

Surely, the man who is responsible for the operation of the plant, who sees and handles the equipment every day, should be best able to judge the merits of each piece of apparatus.

And the Engineer out of justice to his employers and to himself, will recommend York Apparatus, which he realizes will give satisfactory results in actual service. That's why more York Ammonia Fittings and Supplies are sold each year than any other make.

There is perhaps no other concern of its kind in the world able to handle such a large number of orders or such a heavy volume of business.

A trial order will convince you of the Superior Quality of York Ammonia Fittings and Supplies.

CANADIAN ICE MACHINE CO., LTD.

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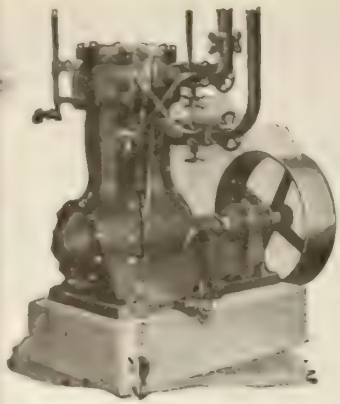
Representing

YORK MANUFACTURING CO.

Ice Making and Refrigerating Machinery Exclusively

YORK - PENNA. U.S.A.



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

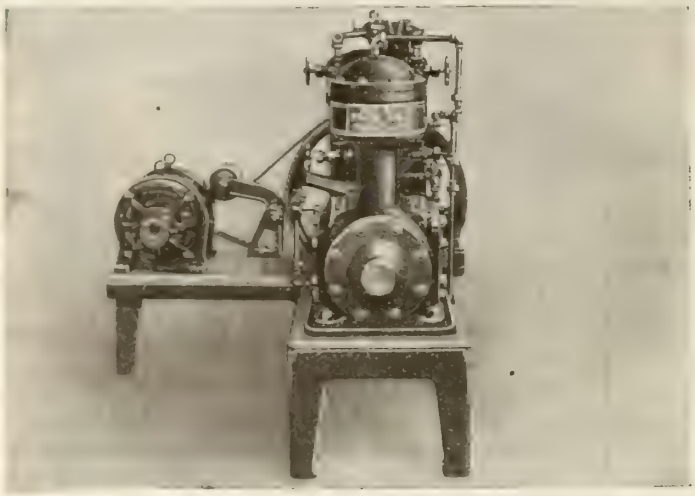
Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



FRICK Combined Refrigerating Machine

This machine fills the needs of dairies, groceries, meat markets, restaurants, hospitals, confectionery and floral shops, etc., for a simple and efficient small refrigerating plant.
The machine is manufactured in one ton and two ton sizes. It is a complete self contained unit, including compressor, condenser, separator, receiver and connections mounted on one solid portable iron base as shown. It is completely assembled in one crate with motor and motor base in separate box, and can be taken through a 26-inch door without uncrating.
No foundation is required. The machine is as easily put in place as the ordinary counter or refrigerator, and as easily removed—an important feature to the user who rents his place of business.

Machine is completely protected with safety devices. Either part automatic or full automatic control is supplied as desired. It is unusually quiet in operation and can be placed in any desirable location.

Ask our nearest distributor for further details and prices.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

NORTHERN CRANES
NORTHERN CRANE WORKS, LTD.

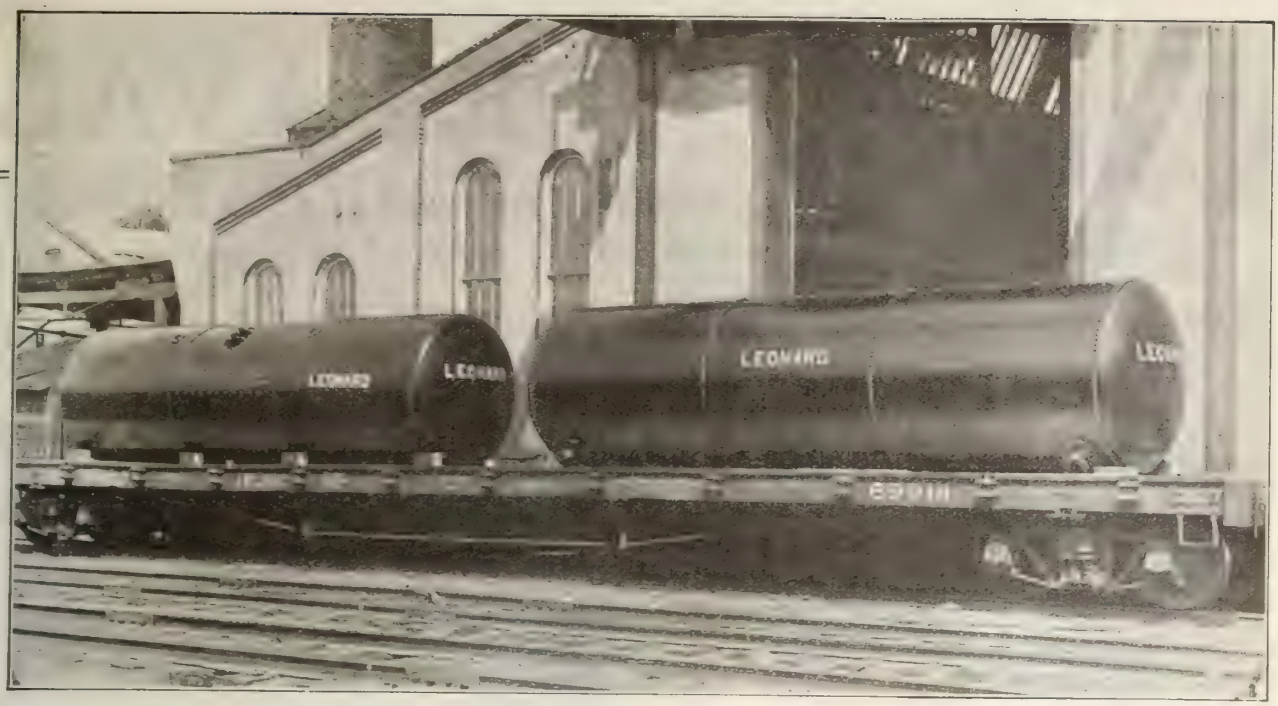
INVESTIGATE THE
ADVERTISEMENTS
APPEARING IN EVERY ISSUE
OF POWER HOUSE

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA



Two 72" x 24 Ft. Pressure Tanks.

E. LEONARD & SONS, LIMITED

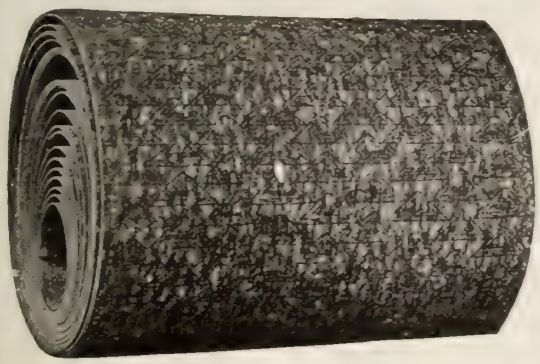
Head Office and Works: London, Canada. Branches from Coast to Coast

Established 1854

LEONARD

Durabla Gaskets Make Tight Joints

Extreme tests prove that Durabla Gaskets can withstand all Temperatures and Pressures without showing signs of Distress.



Wherever a permanent Gasket is required use Durabla. Durabla Compressed Asbestos Fibre Gasket Material makes tight joints on Steam, Water, Air, Oil, Ammonia and Acids. It will not burn out, blow out or pulp at the joints. Durabla is made in convenient size sheets that can be rolled and unrolled. Stamped with the Durabla trade-mark which guarantees strength, goodness and quality.

DURABLA

Stock Sizes

36 in. wide x 144 in. long.

48 in. wide x 144 in long.

In thicknesses of 1-64 1-32, 1-16, 3-32, 1-8.

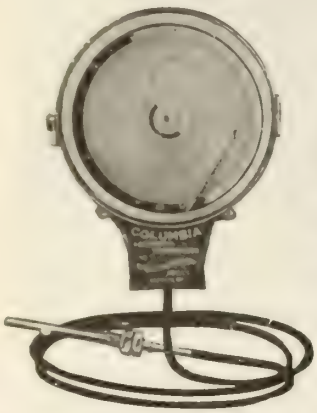
Let us send you a trial order.

Made in Canada by CANADIAN DURABLA, Limited

Distributors : The Canadian Fairbanks-Morse Company, Limited

DURABLA

Columbia
Recording Thermometers



This advertisement is one of a series, each one of which covers one of the many "Columbia" exclusive features. In this way we believe we can best meet the inquiries we are constantly receiving for definite information.

Patent Flexible Insulating Steel Tube

The flexible steel tubing itself is the result of an engineering accomplishment of great note, the capillary bore being only one-hundredth of an inch in diameter.

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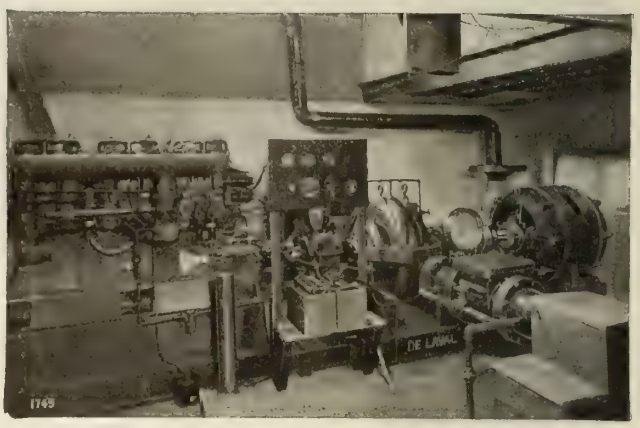

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The low starting torque and high efficiency of De Laval centrifugal pumps particularly adapt them for both electric motor and gasoline drive. The power limiting characteristic of the De Laval pump serves to protect the motor against overload and makes it possible to select a motor developing its maximum efficiency at the normal working output. With induction motors, this makes it possible to realize both higher efficiency and higher power factor.

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239

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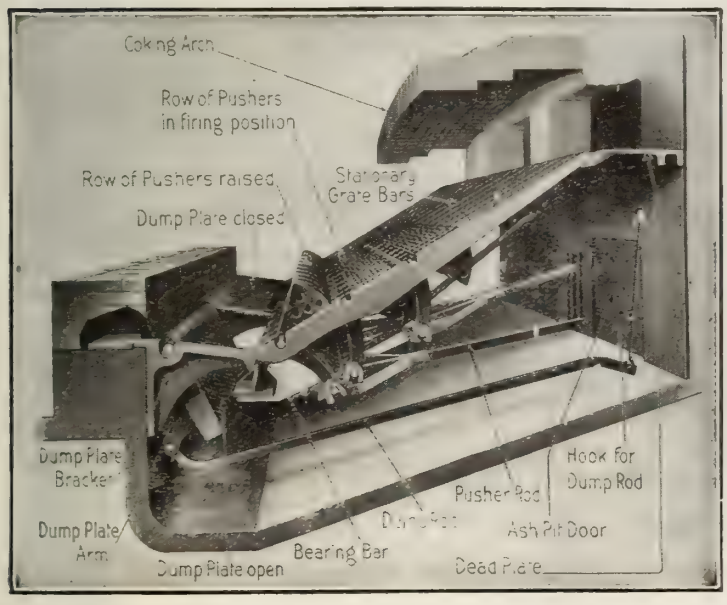

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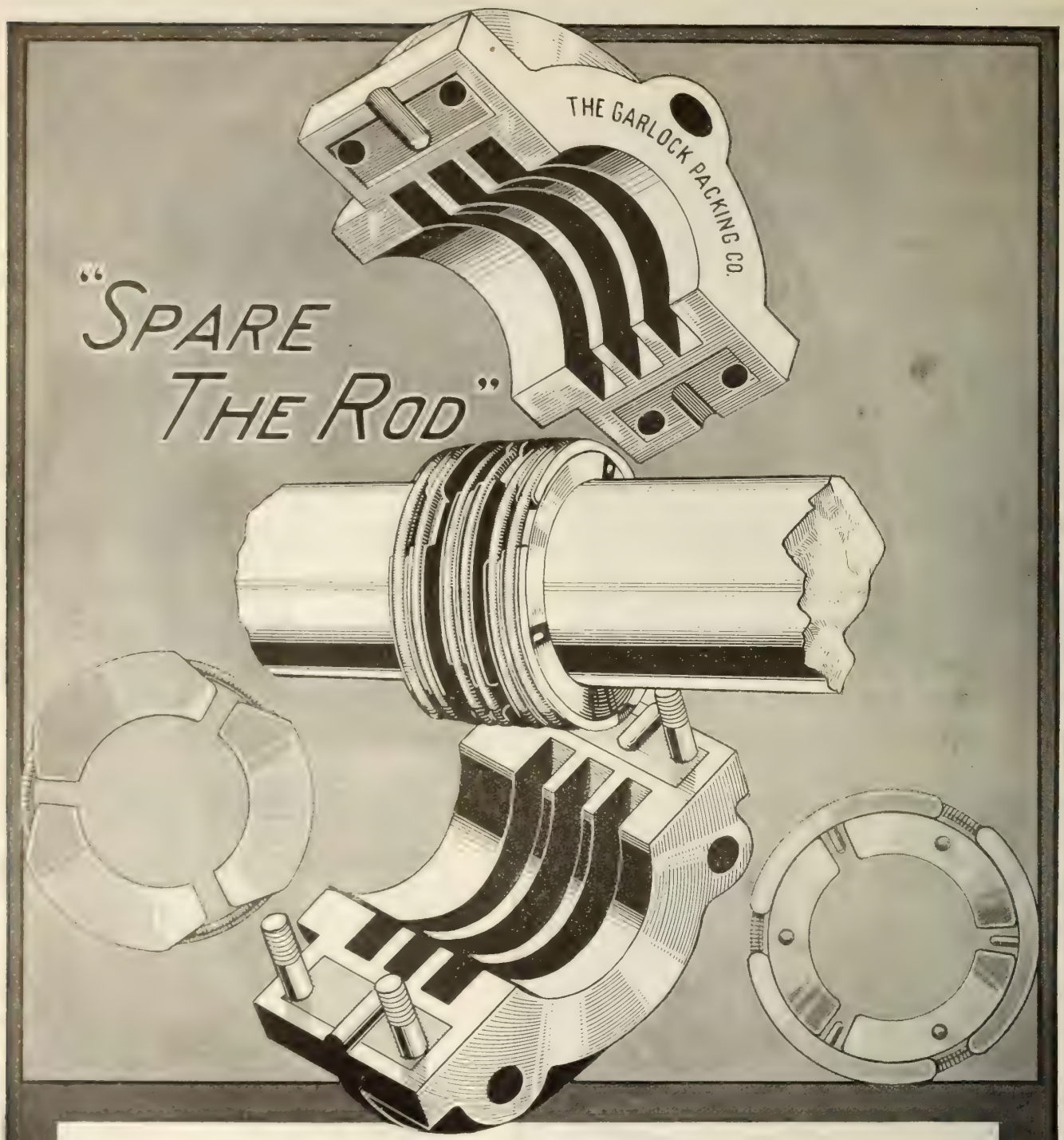

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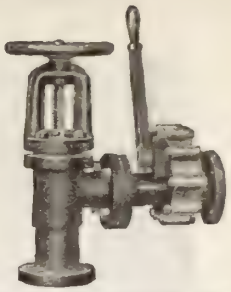

Yarway Seatless Blow-off Valve and Yarway Double-Tightening Valve in tandem — the ideal combination for blow-off lines where two valves are required.

WHEN the Capital Traction Company of Washington, D.C., installed its first YARWAY SEATLESS BLOW-OFF VALVES some ten years ago, it could hardly have been hoped that those same valves would still be in daily service to-day—yet they're right "on the job," as the accompanying recent photograph shows, and tight as ever. Fifteen valves were on the original order—and those same fifteen valves are being operated to-day.

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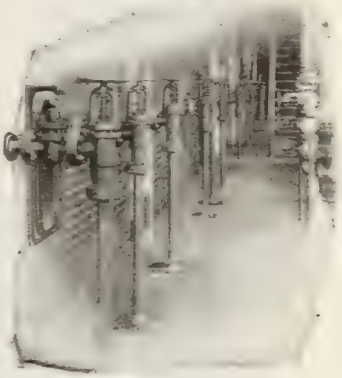

Ten-year-old YARWAY SEATLESS BLOW-OFF VALVES at Capital Traction Co., Washington, D. C.

YARWAY

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LARGE producers of power have almost without exception accepted the DIAMOND Valv-in-Head principle of soot blower construction as correct. They have either changed over their existing soot blower equipment to DIAMOND Valv-in-Head, or are using the new type blower in all extensions.

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A. Eliminates condensate, thus preventing warping of blower elements.

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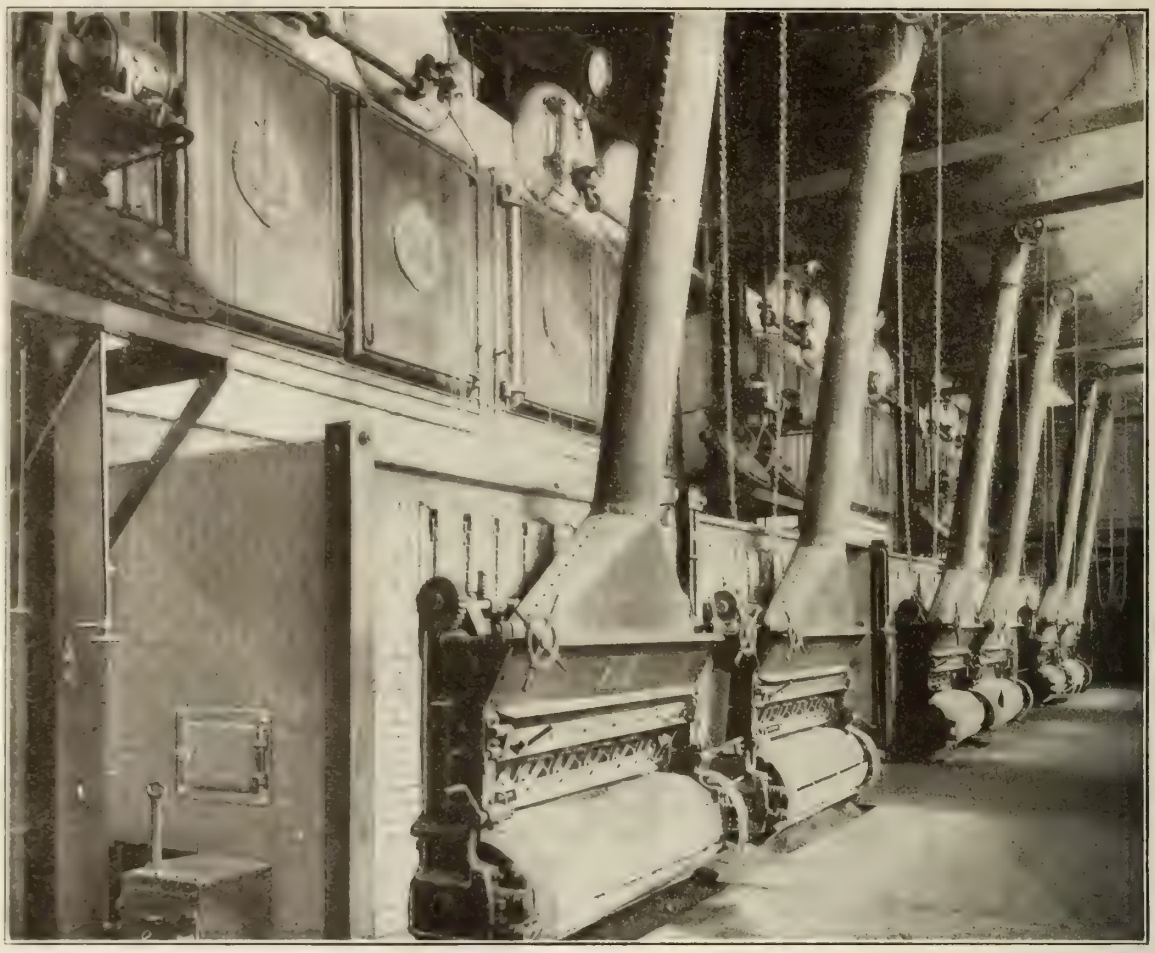

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BOILERS

Illustration shows the Boiler Room of the Howard Smith Paper Mills, Limited, Cornwall, Ont. The following paragraph is from a letter just received from Mr. E. Howard Smith:

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Principles of Levers, Pulleys, and Gear Drives

Methods of Calculation on Lever Safety Valves, Pulley Blocks, and Gear Drives Simply Explained for the Man Who Does Not Understand the Use of Algebraic Formulae

By T. H. FENNER

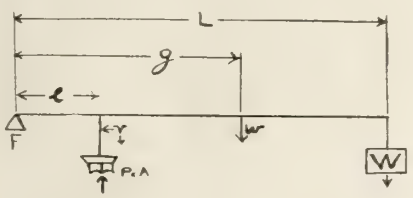
WHILE the lever safety valve is fast receding into the mists of obsolescence, there are still a number of them to be found, and in addition to this, there are numerous other applications of the lever which the engineer has to deal with from time to time. To many engineers the calculations relating to these levers present a somewhat difficult problem, especially to those who plaintively remark that they have no knowledge of algebra. While the formulae generally given are put in an algebraic form, it is quite feasible to work out any of these calculations without recourse to the mysteries of algebra, or at least without the outward forms which usually serve to define an algebraic formula. The Board of Examiners state that a candidate for a first-class certificate must be able to perform the operation of solving simple equations, and this looks formidable to a good many of the older men, and to some of the younger, but it is a fact that most of these men perform simple equations very often without knowing that they are doing so.

It is the purpose of this article to show the method of performing calculations relating to the lever, which includes blocks and pulleys, plain and differential, by what is after all only simple arithmetic such as can be used by anyone who is not familiar with the solution of formulae.

The Lever Safety Valve

Questions relating to the lever safety valve usually involve the finding of one unknown quantity, which may be either the length of the lever, the weight of the ball, the area of the valve, the weight of the valve and spindle, the distance from fulcrum to valve and spindle, or the weight of the lever itself.

Now in any form of lever there are two distinct forces, and two distinct leverages at which the forces are acting, and these forces are acting about a certain point, called the fulcrum. There is one condition that must be satisfied, and that is the force and the distance or leverage at which it acts on one side of the fulcrum, must be equal to the weight and the distance through which it moves, on the other side of the fulcrum. The weight and the force may in some cases be on the same side of the fulcrum, but the proposition holds good, that the weight multiplied by the distance from the fulcrum at which it is acting, must be exactly equal to the force, multiplied by its distance from the fulcrum. Now let us apply this statement to a lever safety valve, and first of all the formula will be given in the usual way, and the solution worked out afterwards by ordinary arithmetic and common sense. In the lever safety valve we have primarily, a set of forces acting downwards, tending to keep the valve closed, and another set of forces acting upwards, tending to force the valve open. The arrangement is such that at a previously determined pressure, the forces acting on the valve to force it up will overbalance the forces acting to keep it down, and the valve will open. The arrangement is diagrammatically as shown in the illustration.



The length L is the distance from the fulcrum at which the weight W is acting, therefore the weight XL will be the total force in foot pounds due to this combination. The distance g is the distance of the centre of gravity of the lever, or the point at which the weight of the lever itself may be said to be concentrated, and the weight of the lever itself is designated by the small w. Then the combination of wxg represents another force also acting in a downward direction.

There is still another force acting in the downward direction, and that is the force due to the weight of the valve and spindle, which is designated by v, and this weight is acting at a distance from the fulcrum of l inches. All these forces are acting in opposition to the force due to the pressure of the steam on the area of the valve, and this force is acting at a distance l from the fulcrum also. Now we may say that in general the upward forces multiplied by their leverage are equal to the downward forces multiplied by their leverage. There we have an algebraic equation, and in formula form it looks like this:—

$$(P \times A - v)l = W \times L + w \times g$$

Suppose that the problem is to find the weight of the ball at the end of the lever, all the other quantities being given. Then the formula would be this:

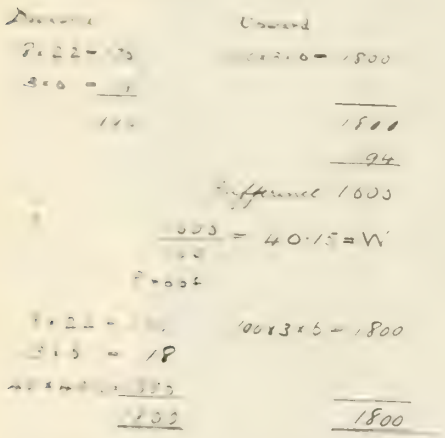
$$W = \frac{(P \times A - v)l - w \times g}{L}$$

Those unfamiliar with algebra will say at once, "How do you get that formula into that shape?" and it is a very natural question, but we are not writing this to teach algebra. Those who understand how the equation is formed will not read this article, and for those who do not, we are going to show a way of finding out the unknown quantity which will be just as good as any formula, but considerably easier to understand. This is how we will do it: First, do not forget that the forces acting down have got to be equal to the forces acting up. Now let us assign some real values to the letters we have, so that we shall have a concrete case.

Let L be 40 inches, g be 22 inches, l be 6 inches, v be 3 lbs., w be 8 lbs., pressure 100 lbs. and area of valve 3 square inches. The problem is to find W. Let us take the upward forces first. They are the pressure of the steam per square inch acting on the area of the valve, at a distance of 6 inches from the fulcrum. Putting this into figures we have
100 x 3 x 6 = 1800 ft. lb.

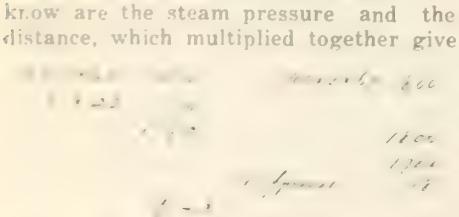
Next take the known forces acting down. These are the weight of the lever, acting at a distatnce g from the fulcrum, and the weight of the valve and spindle, acting at the distance l.

These two forces put into figures will be 8 x 22 = 176 and 3 x 6 = 18 or a total of 194. Now we have on one side a force of 1800 lbs. acting upwards. On the other hand we have a known force of 194 acting downwards, and an unknown force equal to the difference between 1800 and 194. This unknown force like the others is made up of two factors, and we know one of them. That is L the length of the lever, and we wish to know the other. Now if the force is made up of the product of W x L, and we know L and the product of the two, then it is obvious that the product divided by L will give W. Here is the simple way of stating the problem, and this method will enable any unknown quantity on the lever to be found with the minimum of trouble.



It will be easily seen that all the operations are simple arithmetic. Put down on one side of the column all the upward forces and on the other all the downward forces, in both cases this meaning known forces. They should balance. The difference between them must be the unknown force, and as you always know one factor of this force, dividing the known factor into the product gives the unknown factor. Take the problem just given, where the unknown quantity was the weight of the ball. Use this weight as just found, and all the same dimensions, but leave the weight of the valve and spindle as the unknown quantity. As we know what this should be it gives a good opportunity of checking up the work.

Take another case where the quantity not given is the area of the valve. In this case we know all the downward forces, the sum of them being 1800. Of the upward forces the two factors we know are the steam pressure and the distance, which multiplied together give



660. There is another figure to multiply by to obtain 1800, and this is obviously 1800 ÷ 66 = 3, which is the required

The foregoing should make it quite possible for the reader to see the principle. It really is the same thing as the formula in the actual working, but it makes the progressive steps towards the solution absolutely plain, and the reason for them. The same reasoning can be applied to any lever problem, always keeping in mind that the forces multiplied by their leverage which act in one direction, are exactly balanced by the forces multiplied by their leverage which act in the opposite direction.

The ordinary pulley block does not present any complication as far as the calculations are concerned. The ratios of the weight that can be lifted to the force that has to be used is a direct ratio between the number of pulley blocks or the number of parts of rope, divided into L. Thus, if we have a tackle in which there are six sheaves, and there are six parts of rope supporting the weight, then the weight will be divided equally between each part of rope, so that there will be one sixth the weight on each one. The hauling part of the rope then will require just one sixth the weight in order to effect a balance. If the weight moves one foot in height, then each part of the rope that is holding it must move one foot, and as there are six parts, the hauling rope will move six feet. Thus, if we have a weight of 600 pounds and we move it one foot in height, the product of the force by the distance is 600 ft. lbs. If the hauling part of the rope moves six feet, then the force applied must only be 100 lbs., and 100 x 6 gives 600. This is true in any combination of pulley. The velocity of the hauling rope, or the distance through which it moves, divided by the velocity of the weight is equal to twice the number of movable sheaves. In the case we have just described, there are three sheaves in the bottom block, which is the movable one. Then there are six parts of the rope, and the velocity of the moving block is one sixth the velocity of the fall, or hauling rope. On the other hand, the velocity of the weight, divided into the velocity of the rope, is one divided into six, and this gives 6, which is equal to twice the number of moving sheaves.

Another form of block and tackle is the familiar differential block, such as the Weston and others of that kind, usually known as chain blocks. Here the relation of the force to the weight is proportional to the radii of the pulleys and the gearing between them, but the exact relation of force and weight comes back to the relation of the velocity of each.

Gearing and Pulley Drives

The calculation for a train of gears or a number of pulleys can be solved very simply. The rule is to multiply all the drivers together, and all the followers, and then divide the product of all the followers into that of all the drivers. Thus if we have a shaft carrying a gear of 48 teeth, which in turn drives one of 60 teeth, and this again drives one of 90 teeth, the first shaft running at 100 revolutions, the question is to find the speed of the last shaft. The driving gears are 48 and 60, and the following gears are 60 and 90. Then

$$\frac{48 \times 60}{60 \times 90} \times 100 = 55.33 \text{ revolutions}$$

Take another case, such as in a compound winch. We have on the first shaft a gear of 24 teeth, and on the next shaft a gear of 96 teeth. On this second shaft is a third gear of 12 teeth, which meshes into gear of 24 teeth. Then the drivers are 24 and 12, and the followers 96 and 24. The speed of the last shaft is

$$\frac{24 \times 12}{96 \times 24} = \frac{1}{8}$$

or one-eighth the speed of the first shaft. If there is a line shaft running at 240 revolutions, driving a counter shaft running at 200, from which a machine running at 500 revs. has to be driven, and you are required to fit suitable pulleys, then the speed of the second shaft is $\frac{200}{240} = \frac{5}{6}$ of the first, and the machine speed is $\frac{500}{200} = 2\frac{1}{2}$ times the speed of the second shaft.

Then the pulley on the counter shaft must be $\frac{6}{5}$ or 1-1/5 times the diameter of the pulley on the main, and the pulley on the machine must be $\frac{2}{5}$ of the pulley on the counter shaft. Suppose the main shaft pulley is 10 inches diameter, then the counter shaft pulley must be $10 \times \frac{6}{5} = 12$ inches, and the machine pulley is $12 \times \frac{24}{5} = 4\text{-}4/5''$. This is not a standard size of pulley. Suppose we have a 6 inch pulley handy, for the machine. Then the countershaft pulley can be $6 \times \frac{5}{2} = 15$ inches. Then the main pulley must be $15 \times \frac{6}{5} = 18$ inches.

If no suitable pulleys can be found for one reduction then we could use a 10 on the main, driving to a 12 inch on the counter. Then from the counter to the machine we could use another pair of pulleys, say a 20 inch on the counter and $20 \times \frac{2}{5} = 8$ inch on the machine.

The speed of shafts driven by pulleys or gears is in direct proportion to the diameters of the pulleys or gears, and should present no difficulties to any man who understands multiplication and division. In spite of this, it has often come within the writer's notice that men who have pulley drives to arrange have considerable trouble in picking out the size they require for the speed.

High or Low Pressure for Steam Heater

This Most Interesting Question Has Been Treated Very Thoroughly by the Author, and His Conclusions May Occasion Some Surprise to Many of Our Readers

By EDGAR BUCKINGHAM, Physicist, U.S. Bureau of Standards, Member Am. Soc. M.E.

A LETTER recently referred to the writer contained the following requests for information: "We should be pleased to have such advice and references as to permit of our estimating the economy in steam production on a large scale which would be occasioned by generating and delivering steam for vulcanizing at 45 lb. per sq. in. as compared with generating at 190 lb. per sq. in. and delivering at the lower pressure mentioned by throttling through a reducing valve." "Would not a steam engine or turbine, for example, functioning as a reducing valve between 190 and 45 lb. per sq. in. deliver a considerable power output without appreciably reducing the heat-supplying power of the low-pressure steam as compared with the ordinary reducing valve?" "When steam is used for purely heat-supplying purposes, does the use of a reducing valve over a considerable pressure range involve any real efficiency loss, or does the superheat due to throttling bring the available energy back to its original status?"

The engineer to whom the reply was sent wrote: "The conclusions you have reached are indeed surprising, and I trust that you will find the opportunity to prepare them for publication." Without knowing whether the conclusions in question are really novel, the writer submits the substance of his reply in the hope that if these deductions from very elementary principles are known by experiment to be incorrect, the facts may be brought out, for the public benefit, by someone who knows what the facts are.

The Nature of the Throttling Process

The throttling process does not in itself cause any change in the "total heat" of the steam; and if the steam is to be used solely for heating purposes, i.e., only as a carrier for heat, the use of a reducing valve has no direct effect on the economy of the process, although there may, of course, be indirect effects on boiler efficiency and line losses, caused by the difference between generation and transmission at high pressure and at low.

The simplest way to look at the matter is as follows: We start with water at 45 lb. per sq. in. gauge (60 lb. per sq. in. abs.) and the corresponding boiling point which is 292.7 deg. Fahr. We put heat into this water in the boiler; convert it into steam at any pressure we please above 45 lb. per sq. in.; run it through a transmission line to a different place; condense it to water at the original temperature and pressure; and finally feed it back into the boiler.

During this process, aside from the insignificant work of the boiler-feed pump, no outside work is done either on or by the steam. Frictional work against the line resistance is merely dissipated into heat which stays in the steam, and does not count as outside work. A sudden large drop through a reducing valve is precisely equivalent to a great amount of line resistance concentrated in a short length of line. No outside work is done, and the kinetic energy generated at the valve is dissipated into heat which stays in the steam and dries or superheats it.

Since, therefore, the steam, in going round its closed cycle and returning to its original state of water at 45 lb. per sq. in. gauge and 292.7 deg. Fahr., does no outside work and has none done on it, the total amount of heat put into it must also be zero; otherwise the steam could not return to its initial state.

It follows that the heat put into the water in the boiler (plus the small heat equivalent of the work of the feed pump) is equal to the sum of the heat loss to the outside and the heat given up in the condenser—in this case the vulcanizer. This remains true no matter what the upper pressure may be, so that the economic questions to be considered in deciding on what pressure to use, relate to boiler efficiency, heat losses, and overhead.

If the steam is generated at an unnecessarily high pressure, which requires reduction before the steam is admitted to the vulcanizer, the reducing valve may be replaced by a steam engine or turbine. This will give a certain amount of outside work and the heat remaining in its exhaust to be given up in the vulcanizer, will be correspondingly diminished. If the bearing losses of the motor all stayed in the steam, the reduction in the heating value of the steam by its passage through the motor would be exactly the heat equivalent of the work delivered by the motor outside the bearings. Bearing losses which do not go back into the steam as reheat are equivalent to so much heat lost to the outside. They are to be added into the heat loss from the motor, which is itself merely one element of the heat loss from the whole system.

Calculations Dealing With Throttling In The Line

To illustrate quantitatively, we will suppose that the vulcanizer requires 1,000,000 B. t. u. per hour, which are to be given up by steam at 45 lb. per sq. in. gauge condensing at its saturation temperature of 292.7 deg. Fahr. We shall consider three cases: (a) generation and transmission at 45 lb. per sq. in. gauge; (b) generation and transmission at 190 lb. per sq. in. gauge, with throttling to 45 lb. per sq in.; (c) the same as (b) with the substitution of a reciprocating engine or turbine for the reducing valve. We shall suppose, in each case, that the boiler furnishes dry saturated steam, and we shall neglect pressure drop in the transmission line, and heat losses to the outside. Numerical data on steam are from the Marks and Davis tables.

In case (a), dry steam at 45 lb. (60 lb per sq. in. abs.) arrives at the vulcanizer. Its latent heat is 914.9 B. t. u. per lb., so that the amount of steam needed is—

$Ma = 10^6/914.9 = 1093$ lb. per hour.

The furnace has, in any case, to supply to the water the whole 10^6 B. t. u. per hour plus the outside heat loss. The work of the feed pump would be zero if there were no line drop, and is insignificant in any event.

Turning to case (b), the total heat of water at 45 lb. per sq. in. gauge and its saturation temperature 292.7 deg. Fahr. is $H_0 = 262.1$ B. t. u. per lb. The total heat of dry saturated steam at 190 lb. per sq. in. gauge and 384 deg. Fahr. is $H_1 = 1198.5$. The heat supplied in the boiler is therefore $H_1 - H_0 = 936.4$ B. t. u. per lb. This difference consists of 95 B. t. u. per lb. needed to heat the water from 292.7 deg. to 384 deg., and 841.4 B. t. u. per lb. which is the latent heat of evaporation at 190 lb. per sq. in. gauge. If there are no heat losses, the 936.4 B. t. u. per lb. are available for heating the vulcanizer, so that the amount of steam needed is—

$Mb = 10^6/936.4 = 1068$ lb. per hour.

When the dry saturated steam at 190 lb. is throttled to 45 lb. its temperature falls to 334.7 deg., but its superheated 42 deg. Before beginning to condense, it must cool to 292.7 deg., and in so doing it gives up 936.4 — 914.9 = 21.5 B. t. u. per lb. in addition to the 914.9 which it will give up as latent heat of condensation. To put it in another way, the dry steam at 190 lb. carries $936.4/914.9 = 1.024$ times as much heat available for extraction at 45 lb. as does dry steam at 45 lb.; so that the amount needed is only $1093/1.024 = 1068$ lbs. per hour.

In case (c), if the dry saturated steam at 190 lb. per sq. in. gauge were to ex-

pand isentropically to 45 lb. its total heat would fall from 1198.5 to 1102.1 and the difference, or 96.4 B. t. u. per lb., is the "available heat drop" which could be turned into outside work by an ideally perfect motor. The dryness factor of the steam after this expansion through a perfect engine would be 0.918; and the heat remaining available upon condensing to water would be $0.918 \times 914.9 = 840.0$ B. t. u. per lb. which added to the 96.4 makes up the 936.4 originally available.

Supposing that the motor extracts, say, 0.6 of the maximum possible—corresponding to 60 per cent. indicated efficiency in the case of a reciprocating motor—the heat drop of the steam in passing through the motor will be $0.6 \times 96.4 = 57.8$ B. t. u. per lb., so that the total heat of the exhaust is $1198.5 - 57.8 = 1140.7$ B. t. u. per lb. And since the total heat of water at 45 lb. is 262.1, the heat available in the exhaust for use in the vulcanizer is $1140.7 - 262.1 = 878.6$ B. t. u. per lb., the dryness factor of the exhaust being $878.6\ 914.9 = 0.960$.

The amount of steam needed in this case would be, for a motor of 60 per cent. indicated efficiency,

$Mc = 10^6/878.6 = 1138$ lb. per hour

as compared with $Mb = 1068$ when a reducing valve was used. The indicated power of the motor would be $1138 \times 57.8\ 2543 = 25.9$ h. p.

The pump work needed to put the condensate at 45 lb. back into the boiler at 190 lb. is less than 0.5 B. t. u. per lb., so that we have been justified in ignoring it.

Pressure Drop and Heat Loss in the Transmission Line

We may now turn to the question of pressure drop and heat loss in the transmission line, and we shall assume that no motor is to be used so that we have only to compare generation and transmission at a trifle above 45 lb. per sq. in. gauge, with generation and transmission at 190 lb. followed by throttling to 45 lb. Leaving aside the question of capital charges, we shall consider only the heat losses per foot length of the transmission line, assuming that the different lines are all equally well insulated. We may say, as an approximate rule for practical purposes, that the heat loss per foot of pipe in B. t. u. per hour will be proportional to the diameter of the pipe and to the difference between the steam temperature and the temperature of the surroundings.

From this rule it is evident that increasing the pressure (and temperature) of the steam in the line increases the heat loss from a line of given size. But if the high-pressure line can be made small enough the reduction in surface will more than offset the increase of temperature difference, so that the [illegible] be less at the high pressure. The question, then, is whether the high-pressure line can be made small

We here come to an essential difference between heating lines and power lines. In designing a power line the pressure drop along the line, which is merely distributed throttling, must be kept low because throttling diminishes the available heat drop that remains for the motor to work on. But in a high-pressure heating line followed by a reducing valve this limitation on the design is absent; for, aside from the heat losses, it makes no difference at all whether the necessary throttling takes place at a reducing valve or is distributed along the transmission line as line drop. The line drop may therefore be made large, leaving only enough drop at the reducing valve to take care of overload.

This plan seems to present several advantages. In the first place, the line can be made small and its surface reduced. Then the wire drawing in the line tends to dry or superheat the steam, which, of itself, reduces the ease of transmission of heat from the steam to the pipe. Moreover, the wire drawing, while it superheats the steam, reduces its temperature and so again decreases the heat loss. It appears, therefore, that a high-pressure heating line should be designed on entirely different principles from a power line. The line should be as small in diameter as practicable, the limit being set either by the necessity of having some drop remaining at the reducing valve, or, more probably, by the erosion of the line, which may become troublesome when the steam speed is run up very high.

Illustrative Computations of Pressure Drop and Heat Loss

It may be worth while to make some sample computations to illustrate the foregoing. Let D equal the inside diameter of the pipe in ft., S the linear speed of the steam in ft. per sec., M the mass flow in lb. per hour, and v the specific volume of the steam in cu. ft. per lb. Then we have—

$$M = \frac{3600 \times .7854\ D^2S}{v}$$

$$= 2827\ \frac{D^2S}{v}\ \text{lb. per hour} \quad \ldots\ldots [1]$$

Whence—

$$S = (Mv/2827D^2)\ \text{ft. per sec} \quad \ldots\ldots [2]$$

Let P be the pressure drop per foot length of the line. Then since the steam speed is to be high so that the resistance is nearly proportional to the square of the speed, we have, approximately,

$$P = \text{const.} \times S^2/Dv \quad \ldots\ldots [3]$$

where the value of the constant depends on the roughness of the pipe line as well as on the unit used for P. Eliminating S we have—

$$P = \text{const.} \times M^2v/D^5 \quad \ldots\ldots [4]$$

whence—

$$D = \text{const.} \times (M^2v/P)^{1/5} \quad \ldots\ldots [5]$$

To use this equation for designing purposes we should have to take a value of the constant from known experimental results; but for our present purpose of comparing different sets of conditions we only need to assume that it is the same for the different lines compared; i.e., that the lines are similarly rough. If the subscripts 1 and 2 refer to the two sets of conditions, we then have for the ratio of the pipe diameters—

$$\frac{D_1}{D_2} = \left\{\left(\frac{M_1}{M_2}\right)^2 \times \frac{v_1}{v_2} \times \frac{P_2}{P_1}\right\}^{1/5} \quad \ldots\ldots [6]$$

an equation which we proceed to apply to numerical examples.

Let our two sets of conditions be: transmission at 45 lb. per sq. in. gauge; and transmission at 190 lb. followed by throttling to 45 lb. We have already found in an earlier paragraph that $M_{45}/M_{190} = 1093/1068$; and from the steam tables we find that $v_{45}/v_{190} = 7.17/2.237$. Substituting these values in Equation [6] we have—

$$\frac{D_{45}}{D_{190}} = \left\{1.26 \frac{P_{190}}{P_{45}}\right\}^{1/5} \quad \ldots\ldots [7]$$

Equation [7] tells us that if the line drop is to be the same in both lines so that $P_{45} = P_{190}$, the diameter of the low-pressure line must be 1.27 times that of the high-pressure line. The steam temperatures are 384 deg., respectively, and if we assume an outside temperature of, say, 80 deg. we shall have approximately—

$$\frac{\text{heat loss at 45 lb.}}{\text{heat loss at 190 lb.}} = 1.26 \times \frac{293 - 80}{384 - 80} = 0.89$$

Hence if the lines were designed for equal total line drop, the low-pressure line, under ordinary outside conditions, would lose something like 10 per cent. less heat than the high-pressure line.

But suppose that we let the drop be 10 times as great in the high- as in the low-pressure line, so that $P_{190} = 10P_{45}$. Then Equation [7] gives us $D_{45}/D_{190} = 2.02$, and in this case for 80 deg. outside temperature we have approximately—

$$\frac{\text{heat loss at 45 lb.}}{\text{heat loss at 190 lb.}} = 2.02 \frac{293 - 80}{384 - 80} = 1.41$$

so that the heat loss would be considerably less for the high-pressure line. The figures are, of course, only roughly approximate, but they suffice to show the advantage of using high-pressure transmission with a small pipe and large line drop, altogether aside from questions of the capital cost of the line.

Although we have no precise data which would enable us to estimate the probable change in the combined furnace and boiler efficiency caused by changing from low to high pressure, it would seem, in view of the foregoing reasoning, that unless the transmission line is very short, a properly designed high-pressure plant may be made decidedly more economical in operation than a low-pressure one for the same heat supply to the vulcanizer.

(Continued on page 24)

Babbitt as Material for Light and Heavy Bearings

Minimum Wear on Shaft Due to Composition of the Metal—Wearing Qualities of Good Babbitt—Oil Grooves Easily Cut—Various Grades for Different Uses—Method of Handling

By W. S. STANDIFORD

BABBITT as a material for light and heavy machine bearings does not seem to be used to the extent that it deserves; which is due, no doubt, to a lack of information as to its merits as a bearing metal and also to a prejudice against its use on various machines caused by ignorance in handling, as workmen can make the most expensive and high-grade babbitt appear worthless, in regard to the length of time a bearing lined with it will last and the trouble such a metal will make during the operation of machinery causes many factory owners to keep it out of their machine bearings.

Babbitt and brass are mostly used all over the civilized world as a bearing metal on various classes of machinery; both giving good results if they are of fine quality and well made, also suited to the weight of moving parts and plentifully supplied with grease or oil, care being taken not to let such bearings run dry. Brass is an excellent metal for journals and it gives fine results when constantly looked after. In these days of efficiency methods and rapidity of operations, the human element cannot entirely be ignored, and sooner or later, a factory's oiler will neglect to supply a brass bearing with oil when it needs it the most, a cut shaft and bearing resulting in a loss of time and money until the machine can be started again. The oiler in these cases mostly putting the blame upon dust working into a bearing and clogging it up, etc.; when in reality it was his own fault.

Brass and Babbitt

Brass has serious disadvantages when contrasted with babbitt ones which are as follows: owing to its composition, it is a metal that heats up rapidly if for any cause the flow of lubricant becomes irregular or intermittent; heating makes the brass expand rapidly, this in turn causes both shaft and bearing to be pressed together too tightly, the lubricating oil getting rubbed off their surfaces, a "frozen" bearing as it is technically termed, resulting. On the other hand, due to babbitt metal having altogether different characteristics from brass, it will stand more abuse (not that it is advisable to ill treat any machinery), and will run longer before a bearing cuts and seizes a shaft as compared to brass. Babbitt proves to be a very suitable composition for machinery bearings; its advantages in this respect are so great where smooth running machines are desired with the least wear on shafts, that this material gives the utmost satisfaction in factories when it is rightly looked after.

The fine wearing quality of babbitt is due to the fact that it has a more dense grain and also a greasier nature than brass. This gives to it great anti-frictional qualities, thus such a metal will run very much cooler under equal conditions than brass or any other metal. As babbitt can be melted in an iron ladle over any fire, great rapidity in replacing worn bearings in machinery breakdowns is a most desirable feature and also a money saver. In addition, oil grooves can be easily and quickly cut, or if preferred, cast ready made by the millwrights or machinists repair forces using asbestos cord. Uniform bearings are easily obtained in casting such bearings when care is observed in doing the work. Babbitt also has another valuable money-saving feature conferred by its low melting temperature, that allows the use of a portable forge for melting purposes, thus enabling all work to be done on the spot near the engines or other machines. This saves time by eliminating walking of the workers to and fro from the job, to the lowest possible extent.

This metal deadens noise, and last but not least, is cheaper than brass. There are a variety of different grades of babbitt on the market adapted to various machine requirements, such as high pressure and fast speed journals, medium pressure and medium speed and also low pressure and fast speed metals generally contain more tin and antimony with a small amount of copper; while the low pressure and medium speed metals usually have smaller quantities of tin and antimony and a large amount of lead. Tin, antimony and copper confer hardness to babbitts; so it will readily be seen that those who prefer to make their own formula for use in various classes of machinery bearings, can easily regulate its hardness to suit all requirements. There are many varieties of babbitts on the market so that any manufacturer who desires to purchase his own instead of having it mixed at his plant by the repair forces will have no difficulty in selecting a grade suitable for various machines; of course, taking into account the work they have to do as the conditions of working differ in various factories.

Most Suitable Grade

The methods of handling by workmen also have a great influence on the length of time bearings will last. None but high grade men should be employed to re-babbitt bearings. Personally, the writer thinks that, except for a few special cases, two kinds, one a lead-base alloy and the other a tin-base one are sufficient for the average class of machine journals, rolls being included in this list. But each metal ought to be of the highest possible grade that can be made. Rarely are bearings made entirely out of solid babbitt, except some very small ones including those made on die-casting machines, these latter are cast complete with oil grooves, etc. They need only to be turned and faced off before using. In general use, is used only as a lining in bearing shells of cast iron, malleable iron, brass and bronze.

Steel castings were found out by experience to be unsuitable for this purpose on account of warping tendencies when the casting strains are removed by machining. Cast iron shells on account of their cheapness and great strength, are most commonly used for stationary machines, also some malleable ones for the same purposes. The latter class gives fine results in machines which are subjected to heavy vibrations. The railroads generally make use of bronze shells so as to insure the completion of their runs and keep their time schedules as accurately as possible. Bronze or brass shells with a babbitt lining are also made use of extensively in the automobile trade. From the foregoing facts it will readily be seen the esteem in which this metal is held as a bearing material in different lines of manufacture. Owing to varying sets of working conditions encountered in shops and mills, it is necessary to use babbitts of such a composition as will prove suitable in order to have all machinery operate with the least amount of trouble.

Long Wearing Composition

Thus bearings carrying a heavy weight and rotating at high speed, need a metal whose ingredients are varied and also mixed in such proportions so as to obtain the best results. The formula given below is one that has been found out by long experience to give good satisfaction in journals supporting a weight of 2,000 lbs. and moving at a rate of 185 revs. per minute; it being one that enables machinery to continue in action for long periods of time assuming that lubrication is attended to regularly before bearings need replacing.

Formula For a Long Wearing Journal Babbitt

1,400 lbs. lead.
232 lbs. antimony.
165 lbs. alloy. (Tin and antimony mixture.)
5 lbs. bismuth.

In making up this mixture, there is needed a cast iron pot and also some ladles of various sizes; the latter should be of the self-skimming type having a

welded bridge across their spouts so as to prevent dirt and dross from getting poured in with the babbitt. This iron bridge also prevents splashing and enables a good sized stream to be poured. A supply of mandrels, clamps, etc., will also be required by machinist's or millwright's repair forces. In making up the formula listed, experience shows that it is best to melt the tin and antimony alloy and bismuth in a crucible separately from the other ingredients; this is necessary because of the fact that it takes a greater degree of heat to melt them, than lead, as it is a matter of great importance in melting babbitt, (whether it is purchased ready for use or made on the premises) to avoid burning as the latter produces heavy shrinkage in all lining shells, besides reducing its antifrictional qualities.

Mixing the Metal

Such a mixture is also rendered dirty and softer in texture, causing all burnt bearings to wear out rapidly during the operation of machinery equipped with this metal. It is better to melt the lead components in an iron pot until it becomes fluid and then add the well-stirred antimony and bismuth mixture stirring frequently; after which, allow the alloy to remain upon the fire for awhile longer so as to make sure every ingredient is thoroughly melted and mixed. This ensures even wearing journals, the amount of time depending upon the bulk of metal melted. Powdered charcoal or else sawdust should be kept on its surface to prevent oxidation and a formation of dross by the action of the air.

(To be continued.)

ORIGIN OF BALATA

The origin of balata gum, which forms the base of balata belting, dates back about 400 years. It was originally used by the Incas Indians to make crude suits of bull-hide armour, which they had to wear in order to protect themselves against the fatal effect of poisoned-tipped arrows. These suits of armour were composed of two plies of bull-hide, which were welded together with balata gum which they procured from the Bocla tree. These suits of armour were found by the Spaniards at the time of their conquest of that country and were subsequently transferred to European museums as historical relics. The balata gum used in the making of these suits of armour still retains its full strength unimpaired. The same result is obtained by using the Lanco impregnation process in the manufacture of balata belting.

EFFECTIVE BELT SPEED

Practice is still rather uncertain about the ratio of horsepower and belt width, despite the many views—or, perhaps, in consequence of the many views—expressed by investigators. Wider belts for heavier loads sums up the apparent requirement. Speed investigations recently were expressed in the formula that belt speed is almost exactly in proportion to the width of the belt. In relation to high speeds the effect of centrifugal action must be considered, and the conclusion is expressed that nothing is gained by operating a belt in excess of 4,000 ft. per minute. It may be seen from the particulars given, that horse-power increases directly as to speed up to 4,000 ft. per minute, and that at 5,000 ft. per minute the effective tension or pull is reduced about 10 per cent. The preference should be for a maximum of 4,000 ft. To secure transmission at a higher speed it becomes necessary to increase the tension of the belt to a point beyond economical operation.

The centre lip should be at about 45 deg. to the cutting lips of the drill. The drill is in best condition when the chip comes out in a close coil.

Taking Moisture From Compressed Air

MOISTURE is mixed with air in the form of transparent and invisible vapor, until a humidity of 100 per cent., or the point of saturation, or the dew point, is reached and this dew point is always reached in compression and transmission of air at ordinary working pressures, say six atmospheres or 75 lb. gauge. Immediately when this point is passed, the excess moisture condenses into actual water but is still mixed with air. The saturation point of air constantly varies, and is determined by its pressure and temperature, especially the latter and, at a fixed temperature, any given volume of air is saturated when it contains a certain quantity of water vapor. Now, if the absolute pressure of a certain quantity of air is, say doubled, by which the volume is reduced ½, the moisture carrying capacity is reduced the same proportion so that if the humidity of free air is 50 per cent., this humidity becomes 100 per cent. when air is compressed to two atmospheres (15 lbs. gauge) and if compressed to six atmospheres (75 lbs. gauge) the humidity becomes 300 per cent., and 200 per cent., of the air will refuse to carry water as vapor if the temperature remains constant.

As air is compressed its temperature rises rapidly and with each rise of about twenty degrees its capacity for carrying moisture is doubled. Starting with free air at sixty deg.; as it is compressed to 75 lbs. gauge, its temperature at delivery no matter how perfectly the compressor cylinder may be water jacketed, will be about 300 deg., so that in consequence of this change of temperature, the capacity of the air for moisture will have been doubled so many times that when it leaves the cylinder the real humidity will be quite low although it still carries all the moisture with which it started.

When the air is lowered in pressure, as is the case when being used for operating pneumatic tools, air rammers, or any other use where the kinetic energy is converted into work, this excess moisture will show up in the form of water and the water content will be very noticeable where the air is delivered into much lower temperature than that at the compressor. If however this compressed air is pre-cooled to a temperature not in excess of that of the point of delivery or usage, the moisture will be precipitated at the point of pre-cooling and a separator placed between the pre-cooler and point of delivery will eliminate the moisture and deliver dry air, provided the moisture removed does not in any way come in contact with the air passing through the separator.

In many cases there is sufficient cooling surface in the pipe line, which is exposed to atmospheric temperature, that it is not necessary to install after-cooler; however the following tables will enable you to determine whether or not there is sufficient cooling surface in the pipe line or if after-cooler is required the approximate size can be figured from the table showing required cooling surface for free air delivered. The following table shows the length of pipe containing one square foot of cooling surface:—

Size,	External Surface,	Internal Surface
¾ in	3.637	4.635
1 in.	2.904	3.645
1¼ in.	2.301	2.768
1½ in.	2.01	2.371
2 in.	1.608	1.848
2½ in.	1.328	1.547
3 in.	1.091	1.245
3½ in.	.955	1.077
4 in.	.849	.949
4½ in.	.764	.848
5 in.	.687	.757
6 in.	.577	.63
7 in.	501	.544
8 in.	.443	478
9 in.	.397	.427
10 in.	.355	.382

* As suggested by the United Machine and Mfg. Co.

HIGH OR LOW PRESSURE FOR STEAM HEATER

(Continued from page 21)

The information requested may be summarized as follows:

a The use of a reducing valve in a steam-heating line does not, in itself, have any effect on the economy of the heating.

b If a steam motor is substituted for the reducing valve, the heating value of its exhaust is decreased by the amount of heat turned into work by the motor.

c Line drop is merely distributed throttling and has no direct effect on the final heating value of the steam.

d By generating at high pressure and transmitting through a small line, with large line drop, the heat loss from the line may be made much smaller than when the pressure is low throughout the system.

European Central Power Stations

By C. W. E. CLARKE,
Power Engineer Dwight P. Robinson & Co.

ONE NOT acquainted with the conditions surrounding the electric light and power industry in England and on the Continent is apt to meet with a succession of surprises because of the lack of similarity in methods and also because central station development in those countries is at a decidedly earlier stage than ours. Greater London, for example, instead of having a few large central stations is supplied with light and power from more than forty separate plants. The majority of these, moreover, are not along the Thames, as one might except, but are located in various parts of the city and are operated by means of cooling towers. The main reason for this peculiarity is not hard to find when one remembers that Greater London is composed of many boroughs or districts, each of which, in general, has its own light and power supply.

London Stations

The largest plant in the London district and one of the largest in England is the Lots Road Station of the London Electric Railway Company, with a total capacity of 83,000 kw., consisting of six 8,000 kw. machines, one 15,000 kw. and one 20,000 kw., the latter two just recently installed. All turbines are of the Parsons type with generators made by the Metropolitan Vickers or old British Westinghouse Company. This station was originally built by Chapman, an American engineer connected with Yerks at the time the so-called "Tuppenny Tube" was constructed in London.

Two other stations in Greater London are the Poplar Station and the Grove Road Station. The former is a small municipal plant supplying the Borough of Poplar and is of no particular interest other than that it has one of the earlier installations of air pre-heaters which is still giving a good account of itself. The Grove Road Station of the Central Electric Supply Company is a privately owned enterprise. This station operates on cooling towers and originally contained reciprocating engine units which have since been changed for turbine units. At present the plant contains one 10,000 kw. and two 6,000 kw. units and a 15,000 kw. machine is now being installed—all of the B. T. H. type. This plant is a very creditable piece of reconstruction work on old property and is interesting also because of its peculiar load condition, the summer load being about half the winter load, which —by the operating of all cooling towers in summer—enables the plant to maintain approximately the same vacuum throughout the year.

Other British Stations

On my visit to The Rugby Works of the British Thomas Houston Company, I had the privilege of inspecting their latest construction on units of from 5,000 kw. to 15,000 kw.

Another plant, of interest because of its underfeed chain-grate stoker installation, is the Wolverhampton Corporation Electric Supply plant at Wolverhampton. Chain-grate stokers in England are usually either the so-called Underfeed or the Babcock & Wilcox type. The Underfeed design for forced-draft stokers is somewhat different from the usual type of chain-grate with which we are familiar, inasmuch as it has its own fans mounted on the stoker frame with fans and grate operated by one motor. This makes a very attractive and self-contained unit. The Wolverhampton plant has a capacity of 23,000 kw., consisting of two 1,000, one 2,000, one 4,000 and three 5,000 kw. turbo-generator units.

Several plants of The Birmingham Corporation Electric Supply Company were inspected. The Summer Lane plant, the largest, is an old plant with a capacity of 34,000 kw., consisting of two 5,000 kw. turbine sets, twelve 1,500 kw. engine-driven sets and six 1,000 kw. low-pressure turbines. The company is completing a new plant called "Nechells" which is to have an ultimate capacity of 105,000 kw., the first installation consisting of two 15,000 kw. units. The plant is to be operated on cooling towers. The steam pressure will be 325 pounds with superheat at 272° F. The boilers are of the Babcock and Wilcox type and, in accordance with the usual practice abroad, are fitted with economizers. Draft is produced by the so-called Prat system, an induced draft system operating by discharging a fairly high-pressure blast of air through ejector nozzles in the centre of the stack, thereby creating the required draft for combustion. The stacks which flare from the bottom are rather grotesque in appearance. It is interesting to note that this plant is also equipped with so-called "iron-clad" switch gear. Buses and all connections to switches are run in steel, box-shaped conduits which are filled with insulating material after the buses are installed. It is expected that the "Nechells" plant will be in operation this Fall.

At Manchester there is the Stewart Street Station of the Manchester Electric Supply Corporation, a plant of 92,500 kw. capacity consisting of one 4,000 kw. engine-driven unit and one 7,500 kw., one 5,000 kw., three 6,000 kw., one 15,000 kw., one 18,000 kw. and one 25,000 kw. turbo-generator sets. The Manchester Company is also building a new station at Barton designed to contain at present three 25,000 kw. turbo-generator units. At the time of my visit, the steel work was completed and the building was about ready for the installation of equipment. The Barton station should prove to be an interesting development since it is one of the newer designs and contains, among other up-to-date features, a very complete heat reclamation system. They expect to have this plant in operation the latter part of the year but, judging from the condition of the work, I am inclined to think it may be some time later before they go into actual operation.

I had the pleasure of going through the works of the Metropolitan Vickers Company, a large turbine manufacturing concern at Birmingham, and in my opinion the products of this company, especially the turbo-generator units, are the finest in Europe. In fact, I question if they are not better in some features of design and construction than the turbines we are using in this country. They are building machines regularly of from 15,000 kw. to 25,000 kw., the popular size apparently being the 15,000 kw. machines. The character of the work and the general design are excellent. One novel feature is the provision for steam extraction for feed-water heating by installing the heater as an integral part of the turbine base. This method has a great many advantages and I would expect to see machines along these lines built in this country before very long.

The Dalmarnock Station at Glasgow is a relatively new development with an ultimate capacity of 200,000 kw. The present plant operates under 275 pounds steam pressure and 300° F. superheat. In my opinion this is the best plant I saw in England. It is operated under commercial load at a heat consumption of between 18,500 and 19,000 B.t.u. per kw.-hr. with coal containing about 12,000 B.t.u., a very good record especially when it is considered that the yearly load factor is less than 30%.

The Clydes Mill Station of the Clyde Valley Electric Power Company, near Glasgow, was visited. This has two 5,000 and two 15,000 kw. turbo-generator units. The main features of interest about this plant were the two large units which were built by the Metropolitan Vickers Company.

European Stations

In France I visited four stations, all in the environs of Paris. The Saint Denis, Saint Ouens and Issy les Moulx Stations of the Compagnie Parisienne Distribution d'Electricité and the Gennevilliers Station of the Union d'Electricité. The main interest in the first three stations lies in the use of the Belleville type boiler, a rather remarkable piece of equipment and so unlike a boiler as we know it as to cause remark from Americans. The tubes are

threaded into the tube header and further held in place by lock nuts.

The most interesting station in Paris is the new Gennevilliers Station, designed to contain ultimately 200,000 kw.; three 40,000 kw. units are now being installed and the two remaining units are on order. This station is more American than any on the Continent and shows the ear-marks of the designer's visit to this country about three years ago. Unless trouble is encountered with the condensing equipment, which looks rather small, I expect this station to prove to be one of the best in England or on the Continent. It is especially noteworthy because of the large size of the units and the air pre-heaters with which the boiler plant is equipped. This is the largest installation ever attempted along these lines and the result should prove interesting. The boiler plant is arranged with three parallel lines of boilers, two rows of Babcock & Wilcox with chain grates and one line of large Stirlings, double-fired by Riley stokers. The Babcock & Wilcox boilers are set rather low, but the Stirling units have very fine combustion space provided for them. This plant was starting to operate at the time of my visit and should soon be in service.

In general both in England and on the Continent the usual practices of construction and design differ materially. In central station work especially one sees the mark of the manufacturer rather than of the engineer, the latter apparently accepting without very much question the opinion of the manufacturer as to how apparatus should be installed and utilized. This is particularly apparent in the setting of boilers, which both in England and France are still set very low with small combustion spaces. It is not uncommon to see a 1,500 h.p. boiler set with the front header 8 feet or 9 feet from the floor, whereas today 15 feet to 20 feet would be considered good American practice. The almost universal use of economizers is another noticeable point of departure from our practice, for their installation is apparently in no way controlled by load conditions, cost of fuel, etc. The use of air heaters is becoming more general, although I saw no good representative installations of heaters in operation. Several are under construction, however, and by this time the installation at Gennevilliers is very likely in operation.

The European method of rating boilers is another point of departure from our custom, inasmuch as they base ratings on evaporative capacity, a logical method except where a boiler is designed for a certain number of square feet of heating surface. In this case, due to variant ideas of builders as to what constitutes good practice in terms of evaporation (in pounds of water) per square foot of heating surface, the relative evaporation rates might be radically different.

Some of the structural steel designs used abroad are worthy of comment. Apparently there is a very general tendency to use heavy rolled shapes in designing columns and beams, while from our point of view the use of plates and angles would be better practice. For example, I-beams with channels riveted on both flanges are used for columns, and I-beams with single or double cover plates are used in place of girders. In the construction of large steel skeleton buildings the sides are covered for the full height with temporary scaffolding. Apparently the present-day hanging scaffoldings widely employed in this country are not used. However, in considering all these matters it is necessary to realize that the builders in England are in the hands of what is called the Board of Trade, a rather arbitrary governmental organization which sometimes does not permit the use of methods or devices which we consider good practice on the ground that they are dangerous operations. This very likely has some bearing on what, off-hand, we would consider un-economical design.—The News.

POWER EXPOSITION AND THE ENGINEER

The National Exposition of Power and Mechanical Engineering which is to open at the Grand Central Palace on Thursday, December 7, for a week, except for the intervening Sunday, will clearly demonstrate to the general public that the engineer is a tremendous force in civilization today.

We are living in an age made possible by the utilization of inventions and researches, but of the millions of people in the world only a few hundred thousand have any definite conception of the multitude of great ideas that have been put to work for the benefit of humanity.

Thousands of individual engineers are daily challenged by the problems involved in the provision of materials for our buildings of steel, cement and glass which are lighted by electricity, served by mechanical elevators and heated and ventilated by the power and heat from natural sources, but in distinction to the doctor and lawyer these individual engineers do not see their clients. The beneficiaries of their services may be on the other side of the globe.

To show the general public how much it needs the engineer is a very important purpose of this Exposition. But, further, engineers themselves, to be successful must specialize and few can keep in touch with the great strides that are being made in other fields of engineering than those with which they have immediate contact.

The great diversity of exhibits insures the particular appeal that this Exposition will have to all engineers as it will permit them to learn quickly and thoroughly of the progress in the arts and sciences of mechanical engineering. All industries using heat or power in any form will be interested in the displays of steam turbines, steam engines, steam boilers, feedwater heaters, superheaters, economizers, metering devices, stokers, coal handling apparatus, valves and pipe fittings, and the thousand and one important details that enter into what is known as a power house. Each of the exhibitors is planning to emphasize in an instructive way the features of his product which denote progress. In this way not only will the men who understand and use these devices be benefited, but the general technical man and the public will have a greater understanding of the intricate problems involved in the production and use of power plant apparatus. The scope of the Exposition includes mechanical machinery and machine tools such as are included in any completely appointed machine shop and is such that benefit will accrue, not only to the engineers of the great cement, ceramic, metallurgical and power generating industries whose fuel and power problems are severe, but also to the industrial manufacturer whose power costs are a relatively small part of the total cost of manufacturing his product.

The attendance of mechanical engineers and those specializing in refrigeration is assured by the scheduling of the Exposition at the close of the meetings of The American Society of Mechanical Engineers and the American Society of Refrigerating Engineers. The opportunities for professional fellowship which these meetings offer will be extended through the week of the Power Exposition. The American Society of Mechanical Engineers will have a headquarters booth at the Grand Central Palace at which all of the members will be made welcome and services extended. Members of both of these societies will be admitted to this Exposition by display of their badges or on presentation of their membership cards.

FLASH POINT OF OILS

Inasmuch as it is impossible to state from purely scientific determinations the probable hazards of any particular petroleum or petroluem product, the industry has for a long time determined the flash point as an indication of the temperature of danger, states the Bureau of Mines in Serial 2,400, "Fire and explosion hazards of petroleums and petroleum products." The flash point of an oil may be stated as the lowest temperature at which it gives off vapors in sufficient quantity to form a flammable mixture with air. The higher the temperature at which flash occurs, the less is the hazard of an oil from fires or explosions. Information regarding the determination of flash points is given in Serial 2,400, which may be obtained by addressing the Bureau of Mines, Washington, D. C.

A plant for manufacture of asbestos products, the first of its kind in Canada, is being erected at Asbestos, Que., to cost $100,000. At present the raw material is shipped out of the country and imported as a finished product.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field. Steam. Electricity and Refrigeration.

TORONTO, NOVEMBER 5 1922

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Practical Help of Technical Paper

THERE ARE many men who are inclined to deny that a technical paper is of real help to them in the practical problems of everyday life. We venture to say that if this is the case, it is more the fault of the man himself than of the technical paper. Cases are continually coming to our notice of advantage being taken of some particular article by a reader who reads with intent to profit. Only the other day we met a man who frankly admitted that after reading a recent article on the handling of fires to prevent clinkering, he had reduced his labor by a considerable amount, and incidentally saved his employer considerable fuel. Perhaps a number of other men who read that same article read it with their minds already made up that they knew more about it than the author.

Probably one of the hardest things in the world is to convince a man who has been doing a job a certain way for a considerable length of time, and getting away with it, that he is not using the best, or even the right way. The old school fireman is one of the greatest examples of this kind of settled conviction. The writer has had experience with a considerable number of firemen who were excellent men under certain conditions, but who could not be persuaded to alter their methods when those conditions changed. Invariably when it would be pointed out to them that their methods, while good in some places, were the wrong ones for the job of the moment, they would take the attitude that they had been successfully firing for ten, fifteen or twenty years, and knew all there was to know about it.

We take an example of the above kind, knowing it is an extreme one, but perhaps useful for that reason. If a man approaches an article in a technical paper with the idea that there is nothing he can learn, he will not learn. If he only reads one article, on a subject which he is interested in, but reads it thoroughly, and remembers or takes notes of it, he will get benefit from it. On the other hand if he skips lightly through the magazine, glancing at the illustrations and the head lines, he will retain about as much of its contents as he does of the daily paper.

The man that reads a technical paper and reads it thoroughly is put in contact with a means of gathering information that he could not get in any other manner. The technical paper has an outlook which embraces the whole world, and developments in engineering which would never be noticed by the daily press, are received and published by the technical papers. On the other hand, developments in fake engineering which are usually played up large in the daily press, are only noticed by the technical press for the purpose of exposing their false claims. Information found in a technical paper is always substantially correct, and if it should slip, there are enough keen critics to quickly point out the error.

To the man who is following his vocation in the smaller places, where he may but seldom have the opportunity of coming into contact with men in the same line as himself, the technical paper provides a real link between himself and the rest of the world. He can be kept just as much in touch with events as the chief engineer of the largest plant in the largest city in the world. If the paper did nothing more than remind him every two weeks or month as the case may be, that there are other plants and other places in the world, it would be worth spending the nominal amount involved.

Boiler Inspection Laws

FROM TIME to time some correspondent raises the question of the boiler inspection laws of the Province of Ontario, as is the case with L. J. E. in last issue, and "Inspector" who replies to him in this. The question of what are and what are not adequate laws, is one that cannot be disposed of by only looking at it from one angle. From the engineer's point of view, the more stringent the laws are the better he should be pleased, because after all, boiler inspection is a safeguard of the lives of engineers as well as of the property he has charge of. On the other hand boiler inspection laws enforced without a good measure of common sense, may be entirely right as far as safeguarding life and property are concerned, but may very seriously interfere with the legitimate carrying on of industry. There is no doubt an unfortunate division of authority as far as the Government is concerned in the method of boiler inspection, and due to it there may no doubt be cases where boilers escape inspection altogether. The matter of who is a fit and proper person to make a boiler inspection has been touched upon in these columns before, and we say again, that the fact of a man holding an engineer's certificate is not sufficient qualification to make him a competent person to inspect a boiler. A man who is undertaking the serious responsibility of deciding whether or not a boiler is fit for service or not should be a specialist in boiler knowledge, as well as an engineer. We say as well as an engineer, because a boiler inspector should be primarily an engineer, with knowledge of operating conditions, to give him the necessary experience to fit his special knowledge to everyday problems. In the case of the insurance companies, every inspector's report is carefully scrutinized by one or more men who have specialized for many years in this business, and who are familiar as a rule with the history and construction of the boiler in question, the conditions under which it has operated, and the historical record of similar boilers under similar conditions for many years past. In the light of this experience a defect or condition which might be dismissed by the ordinary man as of little moment, may appear much more serious to the chief engineer or his staff in the office.

It would manifestly be impossible to pass a law that would satisfy everybody concerned, for no law has ever done that. The best that can be done is for the operating engineers, the manufacturers, insurance companies and Government departments to meet from time to time and frame such regulations as will ensure the greatest degree of safety with the minimum of inconvenience to all concerned.

The Operators' Point of View

B.T.U.	B.HP.	500 HP.	600 HP.	700 HP.	800 HP.	900 HP.	1000 HP.	1100 HP.	1200 HP.	1300 HP.	1400 HP.	1500 HP.	1600 HP.	1700 HP.
12000	3.98	23.88	28.50	33.43	38.21	42.98	47.76	52.38	57.00	62.08	66.86	71.64	76.42	81.19
100	3.95	23.70	28.44	33.18	37.92	42.66	47.40	52.14	56.88	61.62	66.36	71.70	75.84	80.58
200	3.92	23.52	28.22	32.93	37.63	42.33	47.04	51.74	56.44	61.15	65.86	70.56	75.26	79.96
300	3.88	23.28	27.93	32.59	37.25	41.90	46.56	51.21	55.87	60.53	65.18	69.84	74.50	79.15
400	3.86	23.10	27.72	32.34	36.96	41.58	46.20	50.82	55.44	60.06	64.68	69.30	73.92	78.54
500	3.82	22.92	27.50	32.09	36.67	41.26	45.84	50.42	55.00	59.59	64.19	68.76	73.34	77.93
600	3.79	22.74	27.28	31.83	36.28	40.83	45.48	50.02	54.57	59.12	63.67	68.22	72.77	77.21
700	3.76	22.56	27.08	31.58	36.09	40.60	45.12	49.64	54.16	58.66	63.17	67.68	72.19	76.98
800	3.73	22.38	26.86	31.33	35.81	40.28	44.76	49.24	53.73	58.19	62.66	67.14	71.62	76.37
900	3.70	22.20	26.65	31.08	35.52	39.96	44.40	48.85	53.30	57.72	62.16	66.60	71.04	75.77
13000	3.67	22.02	26.43	30.83	35.23	39.64	44.04	48.45	52.87	57.25	61.66	66.06	70.46	74.87
100	3.64	21.84	26.22	30.57	34.94	39.31	43.68	48.06	52.44	56.78	61.15	65.52	69.89	74.25
200	3.61	21.66	26.00	30.32	34.65	38.99	43.32	47.66	52.00	56.32	60.65	64.98	69.31	73.64
300	3.59	21.54	25.85	30.15	34.46	38.77	43.08	47.39	51.71	56.00	60.31	64.62	68.93	73.23
400	3.56	21.36	25.64	29.90	34.17	38.45	42.72	47.00	51.28	55.54	59.81	64.08	68.35	72.62
500	3.54	21.24	25.50	29.73	33.98	38.23	42.48	46.74	51.00	55.22	59.47	63.72	67.97	72.21
600	3.51	21.06	25.28	29.48	33.69	37.94	42.16	46.34	50.56	54.76	58.97	63.18	67.39	71.63
700	3.48	20.88	25.06	29.23	33.41	37.58	41.76	45.94	50.13	54.29	58.46	62.64	66.82	71.09
800	3.45	20.70	24.85	28.98	33.12	37.26	41.40	45.55	49.70	53.82	57.96	62.10	66.24	70.38
900	3.42	20.52	24.63	28.73	32.83	36.93	41.04	45.15	49.27	53.35	57.46	61.56	65.66	69.80
14000	3.40	20.40	24.48	28.56	32.64	36.72	40.80	44.88	48.97	53.04	57.12	61.20	65.28	69.36

24 Hour Daily Consumption of Fuel Based on Calorific Value of Coal And Boiler Load as Determined by Actual Evaporation. Boiler Efficiency 70%.

PRACTICAL EFFICIENCY CHART

By Thomas Parkes

Master Mechanic Crabtree Mills

The following chart, made up from actual observations, may prove of use to readers of Power House. The chart shows in the first column the calorific value of the coal per pound in b.t.u., the second column being the pounds coal per boiler horse power per hour, while the succeeding columns show the consumption at different horse powers, with a boiler efficiency of 70 per cent. These figures, as before mentioned, have been tabulated from actual evaporation tests.

ONTARIO BOILER INSPECTION LAWS

Editor, Power House:

In the last issue of Power House, (October 20, 1922) there was a letter criticizing our Boiler Inspection Laws. No doubt every law on our statute books could be criticized; however, the fact remains that nearly all our laws are far in advance of the requirements of our present industrial requirements. From time to time the various laws and regulations are amended to meet the advances made in the arts and industries. The Ontario Boiler Inspection laws and regulations, have been no exception to this rule. The fact is that the Boiler Inspection department, as such, is of comparatively recent creation, and while it has been administered very efficiently under Mr. Medcalf, yet there is nothing in the records of Ontario Boiler Explosions to warrant any radical change at this time. The mill owners and factory managers are apparently satisfied with the present arrangements. The Boiler Insurance Companies employ competent boiler inspectors who look after the safety of nearly all the high pressure boilers, and surely the large amount of risk carried as boiler insurance is sufficient guarantee to provide for public safety.

Next to the mill owner or manufacturer in point of interest comes the stationary engineer who has to look after the boilers. Few of them, if any, have indicated any dissatisfaction with the present Boiler Inspection Laws. Further in view of the fact that we have had comparatively less boiler explosions than any other province, I submit that it is the surest evidence that we have not only the best Boiler Inspection Laws in the country, and perhaps in the world, but our laws are enforced more consistently than elsewhere. While "any person obtaining permission in writing from the Deputy Minister of Labor, or any licensed engineer may inspect a boiler" under the Factory Act, yet it has been wisely provided in the Revised Statutes R. S. O., 1920, c. 229, pt. 1, paragraph 57, section 5 (a and b) that such "person obtaining permission in writing" shall give evidence that they have had the training and experience to give their judgment, further they must be reliable and of good character. It seems to me quite proper that the design, construction and installation of boilers should be under the Department

of Public Works, while the operation of same should remain with the Factory Department. Further, viewing the matter from the economic side, one can readily understand that to provide sufficient inspectors under either the Factory or Works Department to meet the needs or the requirements of the manufacturers for frequent and urgent inspections (usually on a Sunday) would mean a burdensome expense because of the incidental traveling expenses, fees, etc. Experience has shown that such traveling inspectors would be employed only 10 per cent of their time on actual inspection and 90 per cent. in traveling and waiting; whereas the licensed engineer is always available and is paid only for actual time while making the inspection. Needless to say this extra or occasional fee is now appreciated by the engineer.

"Inspector."

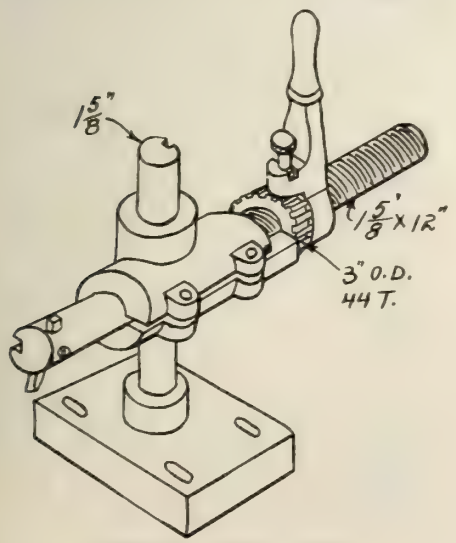
COMMUTATOR TURNING DEVICE

By D. A. Hampson

There were quite a number of direct current dynamos and motors in our vicinity and it fell to our lot to true up the commutators when in bad shape. Besides the larger ones, there were even more of 1 h.p. to 5 h.p. size but these latter were dismounted and the armatures removed for putting in the lathe. It is of those that were more advantageously trued up right in position that we will here consider.

We had an 18-in. planer that wasn't used much and we frequently took the cross rail off, trucked it to a plant, and turned the commutator at night or on a Sunday, using the cross feed for turning, the vertical feed for positioning the tool, and blocking the entire rail up to bring the tool on a center line. These jobs came so numerous and the time spent changing the planer being a dead loss (for the customer) that we made up the portable device shown by the drawing.

This has a flat cast iron base which is attached to some part of the dynamo pedestal, either by tap bolts or through bolts and a clamp. Where we could not conveniently do this, we got permission to put in two or four holes to fit our slots. The upright post shown permits a wide range of adjustment in that direction for the saddle which is bored a close fit and supplied with key and set screw.



Commutator turning device.

At right angles to the vertical post, is the tool shaft and bored hole to fit. For this, the casting is split and binder screws put in, making it possible to snub up as tight as the tool shaft can be fed. The far end of the shaft is cut with a 12 thread screw long enough to permit a movement of 9 inches. A steel nut is made a close running fit on this thread and has ratchet teeth cut on its periphery, to be engaged by the pawl set in the cast iron handle whose hub also rides on the threaded shaft.

An extension of the saddle casting is bored so the steel nut may be dropped in the recess and one half of it is cut away as shown. This provides the stationary member from which the feed movement is obtained. The tool shaft is splined full length. The cutting tool is held by a set screw at the near end. This device is easily portable, can be set up in less time than a machine tool slide, and its use does not tie up a machine. In the six years of its use, it has paid for itself many times over.

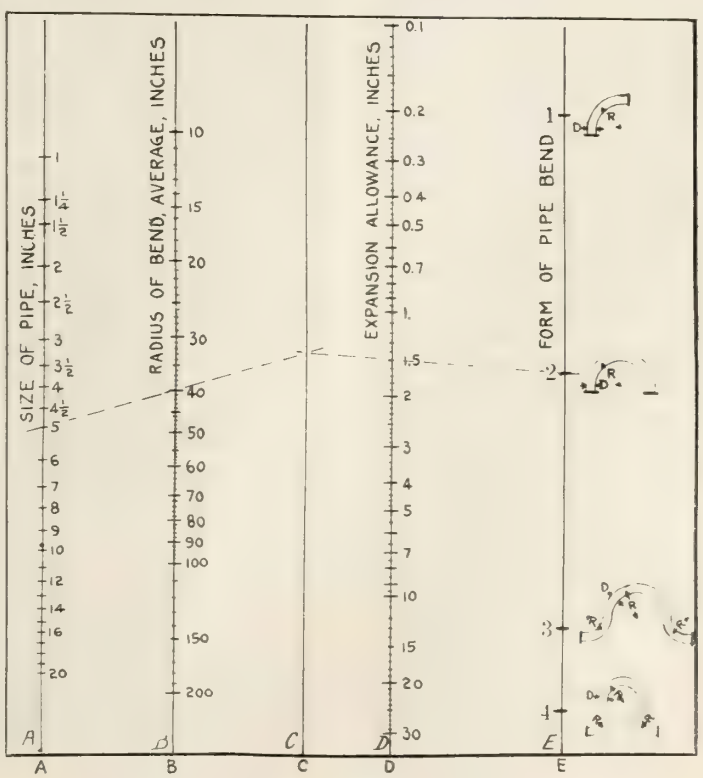
A USEFUL PIPE BENDING CHART

By W. F. Schaphorst

Here is a chart that will be found valuable and convenient for determining the average radius of bend that should be given to common forms of pipe bends, numbers 1, 2, 3, and 4, as shown at the right, column E. Or, knowing the radius of bend, the size of pipe, and the form of bend, column D gives the expansion allowance of that bend.

For example a five inch pipe was made to a radius of 40 in., the bend being a common U-bend as shown by No. 2 in column E. What expansion may be allowed? The dotted line drawn across this chart shows how it is used. Run a straight line through the 5 column A and the 40 column B and locate the intersection with column C. Then from that point of intersection run over to the mark in column E opposite the figure 2 and the intersection through column D gives the answer as 15 inches expansion allowance.

Similarly if the expansion allowance, the form of bend, and the size of pipe are known, the average radius to which the bend should be made may be determined in the same way. In other words knowing any three of the four factors given in columns A, B, D, and E the fourth or unknown factor is easily determined by following the method as explained above. This chart is based upon the following much used and well-known rules: For bend No. 1—Square the average radius of bend in inches and multiply by 0.0026 and then divide by the outside diameter of the pipe in inches. Bend No. 2.—Same as No. 1 but use 0.0052 instead of 0.0026. Bend No. 3—Same as No. 1 but use 0.0104. Bend No. 4.—Same as No. 1 but use 0.013. In the chart all of these operations are already performed—the radii are squared, exact outside pipe diameters are employed, and the proper factors are used.



Pipe bending chart.

FEED WATER AND BOILER CORROSION

Despite the continued advances in internal combustion engines, steam plant continues to keep up with the times, it is noteworthy also that boiler plant which did not, up to a few years ago, keep pace

engine and turbine design is now showing marked signs of improvement, water tube boilers in conjunction with superheaters now being the order of the day in all but some special cases where the Lancashire type still holds its own. There is a tendency to still higher pressures while American engineers are constructing very large boilers, mainly of the vertical tube type. These conditions together with the very high evaporation rates now common render corrosion a very important matter, demanding its prevention at all costs in modern boiler installations.

Naturally the prevention of most corrosion troubles lies in obtaining a suitable feed supply, not always an easy matter.

Suspended impurities can be removed by filtration, mechanical filters are ideal for this purpose, being self contained, simple and effective.

Chemical compounds are far more troublesome while air and oil often present greater difficulties still. The latter of course comes from the condensate, the former would be present in the water to start with.

The chemical compounds such as the sulphates and carbonates of lime and magnesia will form scale if allowed to enter the boiler which in turn will cause overheating of plates and tubes. Periodic scaling is the obvious remedy if they are allowed into the boiler, such methods are of course cure rather than the better method of prevention. These carbonates and sulphates are soluble in hot water hence their deposition in the boiler; in cold water they must be artificially deposited, which is, in fact, exactly what feed water purifiers seek to effect.

In the first place however the water must be analysed, upon the result thereof depends the method of treatment, in general this takes the form of introducing lime to deal with carbonates and soda to deal with the sulphates, a combined process being applied when an excess of carbonic acid is present, this being a very injurious element. There are several well known forms of apparatus on the market for dealing with these impurities, which work on the precipitation principle by different methods, heat being applied in some cases.

The main point about them is that they add or should add the reagents necessary in due proportion to the quantity of water passing for treatment, while some are continuous and others intermittent in action.

They are generally effective and reliable, simplicity being an essential to success. For small plants not warranting their expense the injection of carbonate of soda into the feed is a simple and effective method of preventing incrustation while the several patent compounds have their respective merits.

In marine boilers magnesium chloride is another element that is apt to give trouble. Its action is severe on the heating surfaces, it will especially attack tubes at points where they are comparatively dry, these points being spots where steam bubbles are mainly generated, this condition of steam generation being an established fact, that is to say, steam is not generated evenly over the whole heating surface of any boiler. The resulting deposit of magnesium chloride will produce hydrochloric acid which will bite and even eat through the metal.

For this reason it is most important that dry pipes be fitted in boilers for carrying away the steam, especially when superheaters are used, otherwise magnesium chloride will be carried away with wet steam only to dry on the superheater tubes or projected on to the steam surfaces above water level, with the effect mentioned.

Air in feed water is perhaps the most difficult element to deal with.

It takes a considerable time to boil air out of water, soft deposits can of course be removed by periodic blowing out but air requires degassing methods to entirely eliminate it. A system of continuous blowing down is now practiced by some engineers. It has the advantage of permitting the contents of the boiler to be renewed pretty frequently without a shut down, eliminating mud before it has time to accumulate and allowing the use of carbonate of soda to reduce the bicarbonate of lime. The latter is then decomposed into carbonate which is in turn disassociated.

The water containing caustic soda and carbonate of soda can then be used to purify the make up feed with continuous blowing down methods. One apparatus which works on this principle consists of a steam separator, a reservoir for receiving the blow down liquor and a chamber into which the purified blow down water is drawn off the steam passing into a feed water re-heater, soda being added in the proper proportions through a water meter.

For removing air from water one of the best known methods is that of spraying the feed water into the steam space, means being provided to prevent its getting into the steam pipes, while another is to feed at the usual level exernally and to carry the feed pipe internally and to carry the feed pipe in in a jet which sprays against a hood. Both methods do effectively remove air from the water but unfortunately it is liable to be carried into the superheater and even turbine and engine cylinders where it may do damage, while in the superheater extensive and rapid corrosion of tubes may be set up by the air eating away the natural protective coating of magnetic iron oxide which forms therein.

In order to eliminate oxygen, and air dissolved in water may contain as much as 33 per cent. of oxygen, degassing is necessary. This may be done by agitation and subjecting the water to a vacuum as in the Weir and other systems or by chemical methods. In the latter case highly oxidisable iron is used to absorb the oxygen; the system is employed in Germany and elsewhere but is still in its infancy.

Rusted iron is used. The French system now being developed in England is in the form of iron vessels through which the water either flows alternatively or has its direction periodically reversed. The last named method is somewhat ingenious utilising as it does the iron reaction to cause it to work on the regenerative principle. It is essential in any method of degassing to prevent the water from coming into contact with air after it, while it is advisable to heat it to the highest temperature before feeding.

Oil in water is a trouble that concerns principally boilers supplying reciprocating engines, it being practically non-existent with turbines. It is almost impossible to keep the feed free from it. But with very oily engines it can to a certain extent be eliminated by co-agulating it by means of alumina-ferric, subsequently neutralising the acid and filtering. The main trouble caused by oil is its tendency to spread over the surface of the plates and tubes and so prevent the direct contact of the water with them thereby setting up overheating.

Mechanical oil separators are of course a good deal used. They depend mostly on a sudden change of direction of the exhaust steam, baffles, etc., it being essential in high vacuum condensing plants to keep the baffle plates moist.

The oil can be drained off by some form of automatic trap.

In small steam plants more or less elaborate methods of treating feed water may not be feasible, but in view of the high duty demanded by modern boilers of even moderate size it is most essential that the feed water should be carefully attended to otherwise disaster may occur and as it usually does so when least expected these precautions are not only warranted but positively imperative.

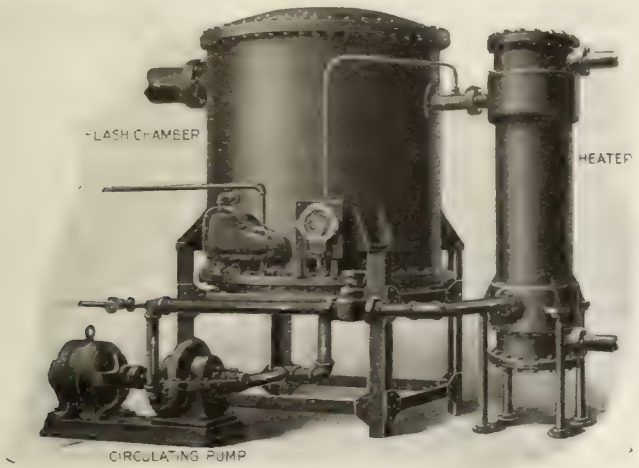
LEAKAGE OF NATURAL GAS FROM PIPES

R. A. Cattell, natural gas engineer of the Bureau of Mines, who is making a special study of transmission losses of natural gas, plans to conduct a series of tests on sections of pipe to determine the relation of leakage to pressure. Although practically all the gas companies have been interested in the subject of transmission losses, comparatively little work has been done to determine certain fundamental facts, such as the effect of pressure on line losses.

SENSITIVENESS OF GASOLINE VAPORS TO IGNITION

Further tests have been conducted at Pittsburgh, Pa., by the United States Bureau of Mines to obtain data as to the comparative sensitiveness of gasoline vapors and methane with respect to their ignition from electric flashes. This work has a bearing on the degree of protection that will be necessary for electric motors used in and around buildings where gasoline vapor may be present.

Progress in New Equipment



THE FLASH Evaporator shown in the accompanying illustration is a new departure in the production of pure boiler feed water.

It consists essentially of a tubular heater, an evaporator proper or flash chamber maintained under vacuum, and a circulating pump. A distilling condenser is also used if the vapor does not pass directly from the flash chamber to the main condenser—otherwise no distiller is required.

The raw water is heated in the tubular heater to a temperature that is both below the boiling point at atmospheric pressure and also below the temperature at which the impurities in the water are deposited as scale. This temperature, to which the water is heated, is, however, higher than the temperature corresponding to the vacuum maintained in the evaporator. The circulating pump maintains the water in the heater under pressure, and as this heated water enters the evaporator, it flashes into vapor due to the vacuum existing therein.

The flash evaporator is well adapted for small, as well as large installations. The distillate produced is practically pure water—when salt water is used as evaporator feed the salt content of the distillate is less than 6 parts of salt in 100,000 parts of water.

Distilled water is cheaply obtained because exhaust steam instead of live steam is used in preheating. In plants where there is not sufficient exhaust steam for operating the system, the additional steam required can be taken from the low pressure receiver of the reciprocating engine or from one of the lower stages of the turbine.

The formation of scale in the heater and the precipitation and accumulation of other solid impurities are eliminated; such scale-forming impurities and other salts remain in solution during the entire evaporation process, because of the low temperature at which evaporation takes place, and because no evaporation can occur on the heating surface of the water heater. The system can be operated continuously.

This non-scaling evaporator not only provides the necessary pure make-up water, but it also supplies this water free from dissolved and entrained oxygen, and hence corrosion of boiler tubes, piping, economizer tubes, etc., is eliminated.

An automatic feed control valve maintains the water in the flash chamber always at the same level.

The internal structure of the flash chamber is so arranged as to divide the incoming water into a multitude of thin films. This splitting of the water into slices or films is one of the outstanding characteristics of the flash evaporator, and is one of the features wherein the flash evaporator differs from apparatus in which the raw water is ordinarily boiled in a large mass just like a large body of water in a tank.

The flash evaporator described is manufactured and distributed by the Schutte & Koerting Company of Philadelphia.

STEAM JET ASH REMOVAL COSTS

The problem of ash handling from the boiler room has been considered a routine drudgery of the worst kind—dirty and dusty, hot and unattractive, haphazard and costly.

With the introduction of the steam jet ash conveyor the operator was relieved of the dirty and disagreeable features but the steam consumption was a variable quantity. Even with the newest equipment steam consumption would exceed expectations.

According to the Green Engineering Company, East Chicago, Indiana, manufacturers of the Green Steam Jet Ash Conveyor, this condition of uncertainty of steam consumption has been met by their REMOTE CONTROL feature which measures the steam and controls the human element in operating the steam jet system.

Briefly this REMOTE CONTROL consists of an electrically operated steam valve; a steam operated water valve and an air flow meter with a clock and chart.

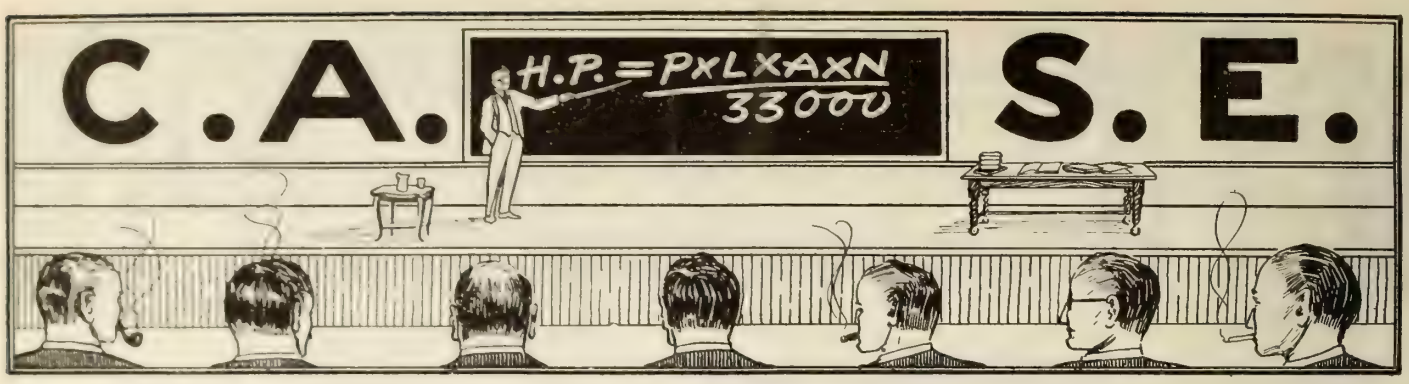
Its operation is as simple as the ordinary steam jet system with the added insurance of control of steam flow and a record of how the ash removal has been accomplished.

When ready to hoe ashes into the intake the operator puts his foot on a button or board and closes an electric switch with his foot. The closing of this switch operates a solenoid in the steam valve leading to the steam jet nozzle. The solenoid opens the steam valve. Located between the steam valve and the steam jet nozzle is a steam line which connects the main steam line to a water spray nozzle. Pressure of steam in this steam line opens the water valve and the water spray functions.

As soon as the operator lifts his foot the switch opens automatically; steam pressure closes the electric valve; and the water valve closes because of lack of steam pressure.

The air flow meter gives a permanent record of the minute by minute suction maintained on the system. It tells the story if the operator lays a brick or stone on the switch and permits the steam to flow while he is not hoeing ashes into the system. This is shown by the nature of the line drawn on the chart. While the system is in proper operation the pen will record jagged lines. When no ashes are being removed the line will be straight along the curvature of the chart.

The Green Engineering Company claim that from a study of actual operating conditions in numerous plants it has been shown that a saving of half the present steam consumption is possible due to the control of the human element in operation.



C. A. S. E. AND EDUCATION

Editor, Power House:

Dear Sir: Your editorial re R. A. S. E. and the C. A. S. E. having similar problems is well taken.

The membership of the C. A. S. E. is composed of all types of engineers, from directors and teachers in various technical schools, mechanical, combustion, electrical, refrigerating, steam and operating engineers, and so on down the line, to the third and fourth class certificate holders.

The educational meeting opens by answering any questions that may be in the Question Box, then proceeds on to the regular educational program. By this it can be seen that any problems that a member needs answering immediately, is soon solved, from such a varied membership.

The present educational program is a splendid one as can be seen by any reader looking up the program in the Power House, August 20th issue.

If there are any drawbacks to it the following examples show the causes: A member is interested in combustion, he turns up to the meeting and the theme is refrigeration for that evening. Another member is interested in dynamos and motors and he decides he will attend a meeting, only to find that there is a demonstration on valve setting of various types of engines and pumps. On another night the theme is, we will say, to be on heat losses and how to prevent them; the member who should attend this discussion goes to a card party or to the theatre or again it may be that he goes to a lodge meeting. Then he wonders how he missed that particular discussion. All these men were at fault in not keeping themselves posted to the educational program, but the last man brings up another problem, that is, which is the best night to hold these meetings.

C. A. S. E., Toronto No. 1, is about to solve the last problem, as membership is increasing so rapidly that in the near future, meetings will be held every night, and there will be classes each night for the different grade certificate holders. By this any member can choose his own night and all may learn from A to Z, engineering in all its phases and from all angles.

I must admit that the educational programs have in the past been of a hit and miss character to the individual member, but one must agree with me that, no one course of papers or list of questions on the various engineering subjects could be drawn up to equally suit all requirements of such members.

I think that now your editorial has brought the subject up it would make a good discussion among engineers to the advantage of all concerned as to "what line of education should be pursued to meet the requirements of such a diversified body of men."

Yours truly,
Geo. A. Brown,
Secretary.

QUESTIONS ON EDUCATIONAL COMPETITION

Subject.—Boilers, Furnaces, Supports And Settings

(1). What are the principal requirements to be taken into consideration when designing a boiler or before putting it into service?

(2). What type or types of boilers have the highest circulation; and is there any objection to a very high circulation?

(3). Assuming the design to be perfect what conditions might obtain either internally or externally to interfere with the circulation?

(4) What relation has the heating surface of a boiler (in different types) to the normal rated-capacity; and what is the limit if any of pounds evaporated per sq. ft. of heating surface per hour?

(5). How should boilers be supported; and what are the regulations for the different types and sizes?

(6). How high above the grate-bars should different types and sizes of boilers be set; and does it make any difference whether it is long or short flame coal which is to be used?

(7). Is there any advantage of using hollow instead of solid furnace walls; and what are the objections to hollow walls rather than extra cost?

(8). How can radiation losses be reduced other than by dead-air space; and would the saving be warranted by the expenditure? Prove it in the case of two boilers 66 in. x 16 ft. 6 in. using 950 tons of bituminous coal (12,500 B. T. U.) at $8.00 per ton.

(9). If one B. H. P. rating is the equivalent of 30 lbs. water evaporated from 100° F. into steam at 70 lbs. pressure, what is the total number of B. T. U.'s required to evaporate same; also the equivalent number of lbs. coal (13,000 B. T. U.) assuming an overall efficiency of 70 per cent.?

(10). If you were called upon to make an inspection under the factory act, what would you look for; and how high would you carry the hydrostatic test?

(11). Why is the girth seam of a H. T. boiler or steam drum stronger than the longitudinal seam? Why is the stress in the girth seam only one half of that in the longitudinal seam?

THIRD SERIES OF QUESTIONS

(1) Give a list of combustibles, with their relative heating value in B. T. U.

(2). What part of the air enters into combination with combustibles?

(3). What are usual products of combustion in the case of (a) coal; (b) oil; (c) wood?

(4). What is the average amount of air required to burn a pound of (a) coal (b) oil; (c) wood; and have perfect combustion result in each case?

(5). What means is there of knowing when you have attained perfect combustion?

(6) What effect does excess air have on the furnace temperature and on the temperature of the exit gases?

(7). What is meant by draft and what is the cause of Natural Draft?

(8) What means is there for measuring or indicating draft?

(9) What is the difference between Induced and Forced Draft?

(10) What effect have air leaks in boiler setting and on the draft; and how would you locate and determine the extent of them?

Geo. J. Soucy,
Chairman.

NEW BRANCH FORMED

On Thursday, Oct. 6th, acting upon an invitation from Mr. James Nichol of Thorold, Past Grand President A. W. Sweet, and Grand Secretary L. J. Ellis, visited the engineers of that district for the purpose of giving them some information as to the aims and objects of the C. A. S. E.

After short addresses by Messrs. Sweet and Ellis, the latter gave an illustrated lecture on A. C. motors and alternators, which was enjoyed by all present, and it was decided to form a lodge of the C. A. S. E. in their town. This was duly carried out, and Messrs.

(Continued on page 33)

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

OIL IN CONDENSATE

Question:—We are using the condensate from a surface condenser for make-up in a cooling pond, and have been experiencing some trouble on account of oil in the water, which becomes deposited on the condenser tubes. We use the condensate as make-up for the circulating water in order to save scale deposits on the tubes, but if we have oil it is just as bad. What would you advise to get rid of the oil?

Answer:—We should think that the most satisfactory method of getting rid of this trouble would be by installing a pressure filter between the condenser and the cooling pond. If there are periods of shut down at week ends or nights one filter would be enough, but if the plant is running continuously then the filter should be installed in duplicate. A settling tank of ample size might be sufficient to allow the oil to separate from the water, and float to the top. The overflow to the cooling pond could be situated about half way up the height of the settling tank, so that any solid matter in suspension could settle at the bottom, while the oil and grease would float to the top. A filter could be constructed from a square or round tank, containing perforated screens covered with cheese cloth or Turkish toweling. There are many good pressure filters on the market and this would be the most satisfactory way out of the difficulty.

CLICK IN FLYWHEEL

Question:—I am operating a Wheelock engine, and there is a loud click in the flywheel every time it makes a revolution, with occasional exceptions. I have tried the nuts on rim and hub, and also the key, and they all seem to be quite tight. Could you suggest the cause and possible remedy for this condition?

Answer:—It is very difficult on a case of this sort without being on the spot, but would say that you should first of all make absolutely sure that there is no side slack in the key, and that the bolts are quite tight. You can test the tightness of the key by the use of feelers and by observation. The key might be quite tight top and bottom, and sound solid to a hammer, and yet allow a slight play on the sides. If you get a man to stand by the valve gear, and move the crank to and fro from each side of the centre, bringing it to a stop each time, and at the same time stand at the fly wheel and watch carefully each time the crank is moved you may be able to detect by oil squeezing out or actually by a slight movement of the shaft before the wheel moves, that there is a side slack on the key.

If you are quite satisfied that there is nothing slack on the flywheel, then the noise is probably coming from some other portion of the crank shaft, and sounds as though it were in the flywheel. If your crank shaft is a very small amount out of line, it will cause a side slip on the crank pin which could easily be mistaken for a noise in the flywheel.

You do not say whether there is a belt driven from the flywheel. If there is, perhaps the belt may be causing the noise, as the splice passes over the wheel. About the only thing to do is to go over every part that might be making the sound, and by a gradual process of elimination to reach the actual cause. How about the wedges in the main bearing nearest the wheel? Is there any slack on the forward or back quarters of the bearing that would allow a movement in the shaft at the dead centres? The wedges themselves can cause a click such as you mention, and that would sound as though it was in the flywheel.

FUSIBILITY OF COAL ASH

Data regarding the softening temperatures of coal ash from several hundred coals from the different fields of the country are contained in Bulletin 209, "Fusibility of ash from coals of the United States." by W. A. Selvig, assistant analytical chemist, and A. C. Fieldner, supervising chemist, just issued by the Bureau of Mines.

Information concerning the fusibility of coal ash has become of considerable value to the consumer of coal, mainly in connection with the troublesome formation of clinker resulting from the melting of the ash constituents of the burning coal. The growing interest in such data has led the Bureau of Mines to make a general survey of the "fusing" or "softening" temperatures of the ash from coals of the United States. It is hoped that this information, when used together with the large number of coal analyses published by the bureau, will assist the consumer of coal in comparing different coals, and in selecting the coal best adapted for his purpose.

Coal ash is the incombustible residue remaining after the complete combustion of coal; it is derived from the inorganic mineral constituents of the coal. The ash-forming constituents are (1) inherent or intrinsic impurities that are present in an intimate mixture with the coal substance, and are derived either from the original material or from external sources such as sedimentation and precipitation while the coal-forming plant remains accumulated; (2) impurities, formed either during the laying down of the coal bed or subsequently, that occur in the form of partings, veins, and nodules of clay, shale, slate, pyrite, and calcite; and (3) impurities that become intimately mixed with the coal in the process of mining, such as fragments of roof and floor.

Coal ash is composed largely of compounds of silica, alumina, lime, and iron, with smaller quantities of magnesia, titanium, and alkali compounds.

Bulletin 209 may be obtained by addressing the Bureau of Mines, Washington, D. C.

NEW BRANCH FORMED

(Continued from page 32)

Sweet and Ellis initiated and installed the officers for the coming term.

Thorold No. 39 started off under a combination of the so-called fatal 13. There were 13 members to start, the number of the branch was 3 times 13 or 13 times 3, and the date was the 26th, another multiple of 13.

The officers and members of the newly formed lodge are all enthusiastic engineers and are going to make their lodge one of the most progressive in the C. A. S. E.

The following are the officers for the present year:

President, J. Leitch; vice-pres., Jos. Conway; sec., C. Davis; treasurer, Jas. Mcgarry; conductor, C. Hudson; door keeper, A. Watson; P. pres., John Nichol.

The thanks of the Grand Lodge are tendered to Bros. Conway and Jas. Nicol for the interest they have taken in organizing the lodge.

Practical Electricity for the Power Plant Engineer

By G. R. ARCHDEACON, A.M.I.E.E.

ONCE upon a time (not so very long ago) the most complicated piece of electrical machinery to be found in the average power house, was the simple electric bell, and as a result the average mechanical engineer was not impressed by things electrical.

To-day things are different, the rapid progress in the design and construction of electrical machinery has been simply phenomenal, and has rendered it imperative that the operative engineer should make himself profoundly familiar with electrical engineering as well as mechanical engineering.

The brief survey given to this subject of the rapid increase in electrical development in the last issue of "Power House" is indicative of the importance to which all things electrical have now to be considered.

To become a "good" electrical engineer, it is first necessary that one should be a "good" mechanical engineer, as the very foundations of the application of electricity are mechanical considerations, such as strength of materials, theory of structures, stresses and strains, mechanical drawing, foundry work, machine tool operation, laws of friction and lubrication, etc.

As the power house engineer is frequently called upon to advise concerning the adaptability of some form of electrical machinery for a particular service in his plant, it is desirable that some little time should be devoted to the study of the special characteristics of the various forms of electrical machinery with which he is likely to come into contact.

In approaching this subject it is necessary that we return to the subject of magnetism, and again briefly review its peculiar relationship to all forms of electrical machinery.

If we pass a few turns of wire round a piece of soft iron, and then connect the end of the wire to a source of d. c. current, the iron will instantly become a magnet.

One end of this magnet will be a south pole, whilst the opposite end will be a north pole.

From each end of this magnet vast numbers of magnetic lines of force will be radiating.

These magnetic lines of force are known as the magnetic field.

Within certain limits, the greater the number of turns of wire which are wound round the piece of iron, or the stronger the amount of current sent round the wire, the greater will be the number of magnetic lines of force radiating from the poles of the magnet.

In other words if we wish to increase the magnetic field, it is only necessary to increase the number of ampere-turns round the piece of soft iron, such as the pole pieces of a dynamo.

It will therefore be readily understood that there is always a magnetic field about a wire through which a current of electricity is passing. This can readily be proved by experimenting with a compass and a length of wire connected to a source of d. c. current.

As the north and south poles of a magnet depend upon which way the current is flowing, it is frequently necessary to be able to quickly determine one from the other.

(a) Grasp the wire by the right hand with the thumb pointing in the direction the current is flowing, the fingers will show the direction of the magnetic field.

(b) Grasp the coil in the right hand, so that the fingers point in the direction in which the current flows, the thumb extended will point to the north pole.

It will be readily realised that there will be certain grades of metals that will be more easily acted upon by these magnetic lines of force, than others. In other words certain metals will have a greater magnetic resistance, whilst others possess a greater "magnetic conductivity."

We must therefore get a thorough grasp of these factors.

Permeability

Is the ratio between the number of lines of force per unit area passing through a megnetisable substance, and the magetising force which produces them.

In other words it is the ease with which magnetism passes through any substance.

Magnetic Flux

The total number of lines of force in the circuit.

Magnetomotive Force

Is the force similar to electro-motive force, in other words, magnetic pressure.

Reluctance

Magnetic resistance, being the resistance offered to the magnetic flux by the substance magnetised, and is the ratio of the magnetomotive force to the magnetic flux.

Magnetic Saturation

Is the point where a large increase in the magnetising force does not produce an apparent increase in the magnetisation. The state of a magnet which has reached the highest degree of magnetisation.

Possibly by considering the analogy which exists between magnetic circuits and electric circuits, the above conditions may become more clearly understood.

(a) Electric circuits, according to Ohm's law.

$$\text{Electric current} = \frac{\text{electromotive force}}{\text{resistance}}$$

$$\text{or Amps} = \frac{\text{volts}}{\text{ohms}}$$

(b) Magnetic circuits.

$$\text{Magnetic flux} = \frac{\text{magnetomotive force}}{\text{reluctance}}$$

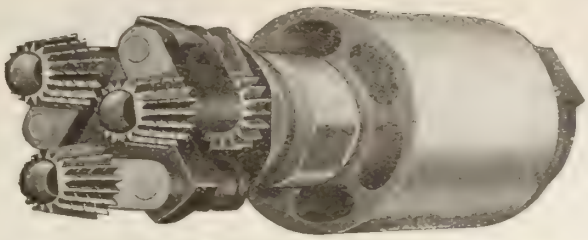
Reduced to practical units this would be

$$\text{Maxwells} = \frac{\text{gilberts}}{\text{oersteads}}$$

Reluctance is directly proportional to the length of the circuit, and inversely proportional to its cross sectional area.

This is calculated as follows:—

$$\text{Reluctance} = \frac{\text{length in centimetres}}{\text{permeability x cross section in sq. cent.}}$$

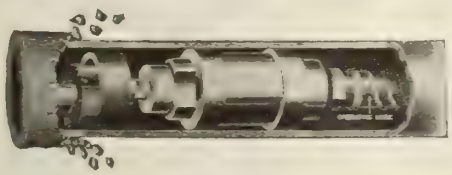


Standard Water Driven Tube Cleaner

KEEP YOUR BOILERS CLEAN

Lagonda Water Driven Cleaner for Curved Tubes

Lagonda Air Driven Cleaner for Straight Water Tubes



Cleaner Removing Scale from Outside of Fire Tube

All natural waters contain some impurities which, when introduced into a boiler, may appear as solids deposited on the heating surface. No matter what the substance consists of, it must be removed at frequent intervals or it will decrease the capacity and efficiency of the boiler and may cause it to be badly damaged by over-heating.

Some waters, notably well waters, deposit such quantities of scale that they should be purified before going into the boiler, thereby preventing an accumulation of incrustation and consequent damage to boiler parts, and at the same time effecting a large saving in fuel by keeping all parts of the heating surface in a clean and efficient condition. If you have bad feed water it is a case for the chemist, for the scale is probably composed of several substances which must be known before the exact treatments necessary to get rid of them can be determined upon. The use of treatment without technical advice is poor policy.

Stony and vegetable matter in suspension can be removed by FILTERS, which we supply in various sizes and designs to suit all requirements. In most Canadian plants, lake or river water is used for feed, and these waters seldom carry large quantities of scale-forming materials in solution. Scale can be allowed to form in boiler for a considerable period. Experience in each individual plant determines the limit at which tube difficulties will begin or a perceptible falling off in efficiency will take place. With such a limit of scale formation fixed, and the danger of allowing it to be exceeded, well understood, probably the most economical and efficient method of keeping the heating surfaces clean is by use of the LAGONDA TUBE CLEANERS.

The cleaners are designed and so constructed as to thoroughly remove all the scale, in the shortest possible time, at the lowest cost of operation, and they require a minimum amount of repairs, reducing both the waste boiler time and labor cost of cleaning.

They are made to operate by either water, air or steam. In every case a swing head is furnished so designed that three sets of cutters are thrown out by centrifugal force against the scale in such a manner that they make straight line contact with the tube and they do the work without damage to it.

You can be supplied with LAGONDA tools for cleaning Economizers, Condensers, Evaporators and other tubular plant.

WE SHALL BE VERY GLAD TO FURNISH FULL PARTICULARS

BABCOCK & WILCOX, LIMITED

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE, BANK OF HAMILTON BUILDING

Hans Christian Oerstead, a Danish scientist, discovered in 1820 that a magnetic field surrounded a wire through which current was flowing from a voltaic battery, yet it remained for our famous Englishman, Michael Faraday, on October 1st, 1831, to cause a current of electricity to become induced into wire from a magnet.

On this date Faraday wound on a wooden block an insulated copper wire 203 ft. long, and over it another insulated wire of equal length. One circuit was then connected to a galvanometer and the other to a battery of 100 cells. Faraday then noticed that at the instant the current began to flow in the wire connected to the battery, a brief current in the opposite direction traversed the other wire in the galvanometer circuit.

Working upon this discovery as a basis for further experiments he succeeded on Oct. 17th in realising his dream, by obtaining a current of electricity from a permanent magnet.

From this date the world can be said to have possessed an electro dynamo, and all electric dynamos, motors, alternators, transformers, etc., in existence to-day may be truly said to owe their origin to this most remarkable Englishman.

Faraday's Law

When a conducting circuit is moved in a magnetic field so as to alter the number of lines of force passing through it, a current is induced therein, in a direction at right angles to the direction of motion, and at right angles also to the direction of the lines of force, as viewed from the point from which the motion originated.

To prove this great theory, it is only necessary to take an ordinary horseshoe permanent magnet and a length of copper wire. Connect the ends of the wire to a galvanometer, make a loop of the wire and pass this loop quickly up and down between the poles of the magnet. The needle of the galvanometer will be seen to oscillate, thus proving that a current of electricity has become induced into the coil of wire.

The modern dynamo and alternator are not made up with permanent magnets such as Faraday used, electro-magnets being used instead.

This is because of the ease with which we increase the magnetic flux, by increasing the power of the magnets; this being accomplished by increasing the ampere-turns round the electric-magnets.

Remember that to cause a current to flow, or become induced into a loop of wire, it is imperative that we cause "a change in the number of lines of force passing through the loop of wire."

The greater the number of lines of force changed in passing through the loop the greater will be the voltage induced in the said loop.

Let us therefore now consider the practical application of these laws to the practical dynamo or alternator.

It is usual to keep these two terms separate, using dynamo to distinguish a d. c. generator, from alternator the a. c. generator.

The word generator is not quite the correct term to apply to either of these machines, as neither of them actually "generates electricity." As the word is popularly employed we may continue to use it in a somewhat restricted sense.

A dynamo and alternator may therefore be considered as machines for changing the number of lines of force passing through the loop of wire. thereby resulting in an electromotive force being developed in the loop of wire by inductance.

In the case of the dynamo there are three principal parts:—Field magnet, armature, commutator.

Field Magnets

These are to provide a magnetic field, and are so constructed that the intensity of this field may be increased or decreased as required.

The magnetic lines of force emanating from the "pole pieces" of these field magnets pass through the loop of wire on the armature.

The Armature

The armature is a "form" upon which the loop of wire is wound. As the armature is rotated between the pole pieces, the number of lines of force being "cut" by the loop of wire varies according to the relative position of the loop with regards to the lines of force.

The Commutator

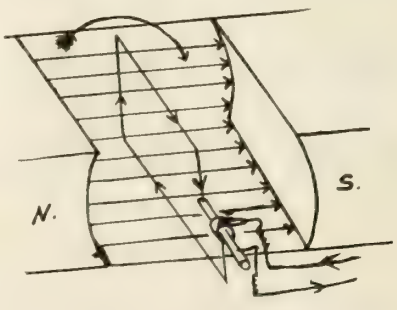
The commutator is a device for changing the alternating currents which are generated in the armature, into direct current.

When the armature is rotated between the pole pieces a current is induced in the loops of wire on the armature. The quicker the armature is turned, the higher will be the voltage induced therein.

The magnitude of the electromotive force induced in the loop depends upon the rate at which the number of lines of force are changed in the loop, therefore the quicker the loop is turned, the higher will be rate of change.

The direction of the current induced in the loop will depend upon the direction of the lines of force, and the direction of the loop.

It is important that we should be able to readily ascertain the direction of the



induced current, as this knowledge decides for us the positive and negative poles of the external circuit.

There are several rules laid down for our guidance in the matter, amongst which the best known are as follows:

Fleming's Rule

If the forefinger of the right hand be pointed in the direction of the magnetic lines, and the thumb (at right angles to the forefinger) be turned in the direction of the motion of the conductor, then will the middle finger (bent at right angles to both thumb and forefinger) show the direction of the induced current.

Ampere's Rule

If a man could swim in a conductor with the induced current, then the north seeking ( ) pole of a magnetic needle placed directly ahead of him will be deflected to the left, while the south seeking pole ( ) will be urged to the right.

The Palm Rule

If the palm of the right hand be held facing or against the lines of force, and the thumb in the direction of the motion, then will the fingers point in the direction of the induced current.

In taking as an example an elementary idea of a dynamo, we assume it to consist of only a single loop of wire on the armature. It will be obvious that the number of lines of force passing through this loop will vary according to the position of the loop. When this loop is vertical to the lines of force, the maximum number of lines will pass through it, but when it is horizontal, or laying parallel to the lines of force, no lines will be passing through the loop, therefore whilst in this position no current will be induced in the loop.

It will therefore be apparent that the voltage will be continually rising and falling according to how near or far away the loop is from the position in which it is cutting the maximum number of lines of force.

Therefore twice in each revolution the value of the voltage will go from maximum to minimum.

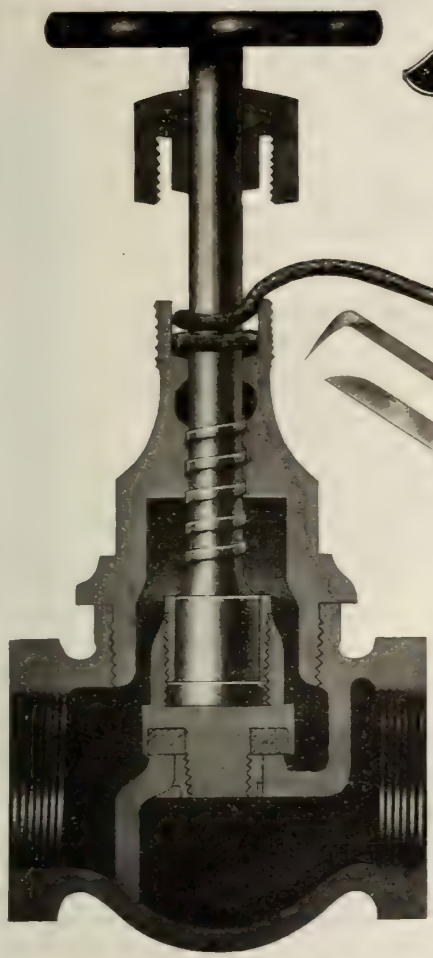
If the armature be rotated slowly these changes will be most apparent, and as the speed of rotation is increased the variation will become less and less obvious to the naked eye.

As there is a limit to the speed we may attain, there still remains another way in which to overcome this difficulty, and that is by arranging another loop on the armature. If this is spaced half way between the original loop we will reduce the voltage variation by one half with a result of apparently giving a steadier voltage. Therefore by continuing to increase the number of loops round the armature we finally arrive at the stage when these fluctuations are of such a short duration that they cannot be detected by the naked eye when the current goes off on its journey to illuminate the electric lamp.

For the generation of one volt it is necessary that the loop of wire (or inductor or conductor, as we shall henceforth term it) should cut one hundred million lines of force per second.

Raybestos PACKINGS

"They Wear Longest"



Reduce Your PACKING Investment

IT MATTERS not whether it be a valve plunger, cylinder head, piston rod or any other operation—you will secure the utmost in service and reduce your packing cost by consistently using **Raybestos.**

Raybestos Packing is Heat-Proof and Acid-Resisting — and it will not harden. It reduces costs.

Raybestos is made from Asbestos secured from Canadian Thetford Mines -— its quality is assured.

There is a Raybestos Packing to meet every requirement of your plant. Specify Raybestos Packings. "They Wear Longest."

The Canadian Raybestos Co., Limited

Peterborough, Ontario

RING PACKING
Style 325

SPIRAL PACKING
Style 425

The equation for finding the voltage of any dynamo is as follows:

Let n = number of conductors in series.
n = number of revolutions per second of the armature.
p = number of magnetic poles.
Φ = magnetic flux per pole.

Then the flux cut per second by any conductor is $n \times p \times \Phi$ lines.

Dividing by 10^8 gives the average volts.

If there are n conductors in series the total e. m. f. is:

$$\frac{n \times p \times n \times \Phi}{10^8}$$

From an inspection of this formula it will be seen that the voltage of the generator can be changed by changing either the speed n or the flux, or the number of poles, p, or number of conductors n.

The last two of course are fixed when the machine is built; the first two can readily be changed by the operator, and afford a practical means of controlling the voltage.

The practical way to control the voltage is by having an adjustable resistance called a field rheostat inserted in the field circuit. By this means the number of ampere-turns round the pole pieces can be varied.

The turns round the poles are of course a fixed quantity, but by means of the field rheostat the amps flowing through the turns is varied, and as ampere-turns is the ratio of amperes × turns a change of either quantities effects the equation.

A rise or fall in speed always has a great effect on the voltage, and it is for such a reason that all engines for driving dynamos must have very delicate governors, and be well balanced, otherwise the speed fluctuation of the engine becomes apparent in the varying voltage of the dynamo, which results in more rapid depreciation of the electric bulbs, and renders the electric light unsuitable for illumination.

NEW BOOKS ON MECHANICAL STOKERS

One of the most interesting publications of the year in the mechanical stoking field is the new bulletin, "Cutting the Cost of Producing Steam," just published by the Detroit Stoker Company, of Detroit, Michigan.

The bulletin starts with the promise that "One of the conditions necessary to the efficient combustion of coal is the uniform liberation of the volatile gases. This is a condition which practically never can be obtained in the hand-fired furnace. Inasmuch as the hand-fired furnace also represents definite limitations in the way of utilizing the cheapest grades of fuel, engineers are today finding that the way to improve boiler room operating conditions is to install mechanical stokers."

From this point the bulletin takes up the dollars and cents value of mechanical stokers, dealing with each of the savings effected, in detail. It next deals with the application of advanced engineering principles and modern stoker design, and then concludes with a section on the service of the mechanical stoker, unique in its treatment.

The bulletin is a beautiful example of the printer's and engraver's art, as well as being one of the most readable and interesting pieces of literature put out in the power equipment field. Complimentary copies will be forwarded to interested engineers and executives upon request.

BULLETINS

The Combustion Engineering Co. have issued a very interesting little booklet on the subject of service, under the appropriate title of "Service Bulletin." This booklet has been published to show exactly the kind of service that stoker manufacturers give to their clients and prospective clients, and also shows that this service has to be covered in the selling price of the apparatus. This results in some clients having to pay a certain proportion of the service charges, when they do not require such service. They are helping out the other customer who does require considerable service, but only pays for a portion of it. The suggestion is made that service should be a definite separate charge, paid for according to the exact amount of service given.

The Young Pump Co., 310 Lister Bldg., Hamilton, have issued a bulletin describing their centrifugal vacuum and boiler outfit. This self contained unit is designed for handling the returns from small heating systems, separating the air, and returning the water back to the boiler.

"Palco" is a new packing described in a folder issued by Greene Tweed & Co., makers of "Palmetto" and other brands. The new packing is adapted to hydraulic and low steam pressures. Canadian representatives are Fairbanks Morse Co.

The Quaker City Rubber Co., Philadelphia, have concluded arrangements whereby the St. Lawrence Supply Co., 167 Commissioners St., Montreal, will handle their goods in the province of Quebec.

ENGINEERS IN ANNUAL RE-UNION

At the fourth annual re-union of the Engineering Alumni Association of Toronto University, Oct. 27 and 28, engineers from all over the Dominion and the United States assembled to renew friendships and visit once more the scenes of their college days. The programme as arranged by the executive of the Alumni, was a complete one, festivities opening on Friday evening with a dinner dance. Saturday morning the year meetings were held at Varsity, all the classes from away back in the eighties down to last year, being well represented.

At the annual dinner held in Convocation Hall, Capt. C. E. MacDonald proposed the toast to the University of Toronto. In replying, Prof. A. T. DeLury of University College, made reference to the Literary and Scientific Club of olden days and said that the Alumni Association was rapidly forming closer bonds between School and the rest of the University.

In replying to the toast to the engineering profession, Dr. A. C. Humphreys, president of the Stevens Institute of Technology, Hoboken, N. J., laid stress on the point that students should be properly prepared in the essentials before commencing an engineering education. Prof. H. E. T. Haultain of S. P. S. proposed the Silent Toast, which was followed by "The School," by W. E. Douglas of the Class of '02, and replied to by Dean Mitchell of the Class of '92. General Mitchell appealed to the Alumni for scholarships saying that it was only by the individual and co-operative efforts of the Association that scholarships could be provided, and that it was in this respect that the alumni could best help the students of to-day.

REPAIRING GASOLINE TANKS

By C. Howard

Should a gasoline tank, or can which has contained gasoline, need repairs for which a soldering iron is to be used, great care is necessary in charring the container of any gasoline fumes which may be in it. If extreme care is not exercised there is a possibility of an explosion occurring. Gasoline fumes being heavier than air will remain in any container for a considerable length of time even though it has an opening to the air. There are several methods of clearing away such fumes of which turning the tank with its opening to the lowest point and leaving it so for several hours is perhaps the easiest. Another way is to subject the container to indirect heat in a similar position to that stated. It is advisable however, to keep the blow-pipe as far away as possible.

CATALOG

The Bristol Co., of Waterbury, Conn., has just issued a new and revised catalog on their varied line of pyrometers. In addition to listing the instruments the book contains a number of specimen charts taken from actual installations. There are also several pages devoted to plans illustrating the correct method of installing the recording apparatus. The application of the fire ends is clearly described and demonstrated by a number of photos and line drawings, showing their adaptation under different conditions.

Now an Entirely Underfed Side-cleaning Stoker

THE ARROWS below are the symbol of a great development in mechanical stoking. They trace the path of fuel travel of a stoker that embodies a new basic design — the "*lateral retort*" principle.

Briefly summarized the advantages of the *lateral retort* design are:

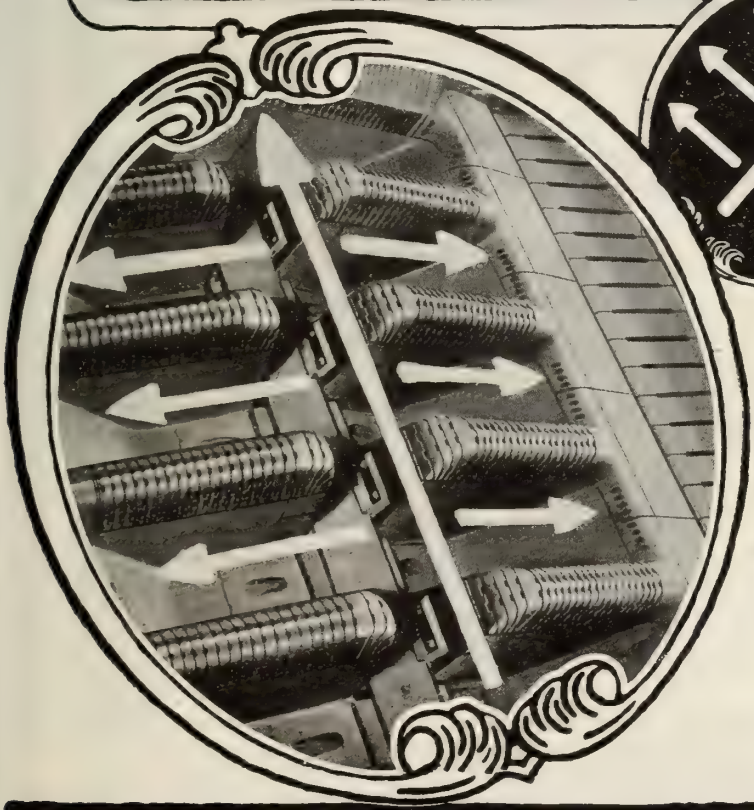
The multiple retort effect. Coal is underfed to the *lateral retorts* as well as to the main or central retort. It is not overfed from the main retort onto side grates as in other stokers employing side dump plates. Consequently, the principle has made possible for the first time; *a truly underfeed side-cleaning stoker.*

Heavy overload capacity. The *lateral retort* design provides a large reserve fuel capacity for meeting overload demands.

Low maintenance. The *lateral retort* construction also permits a simple rugged construction; only two simple steam cylinders and a few moving parts buried deep in the green coal where they cannot burn out. The simple balanced dump plates—of the type that has proved so successful in the Jones "A-C" Stoker—insure an additional saving in maintenance.

Low initial and installation cost. The extreme simplicity permits a moderate first cost, and the side dump construction does away with basement ash pits and expensive excavation. For this reason the *Lateral Retort* Stoker is adaptable to any conditions in existing plants.

The construction and advantages of this stoker are thoroughly covered by a new catalog. Ask for it.



Under-Feed Stoker Co. of Canada, Ltd.
146 King Street West, Toronto

Sales Agents for Jones Under-Feed Stokers, Riley Under-Feed Stokers and Murphy Automatic Furnaces

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Mr. J. Twomey, Camrose, Alberta.
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W.W. Hicks & Co., 567 Banning St., Winnipeg.

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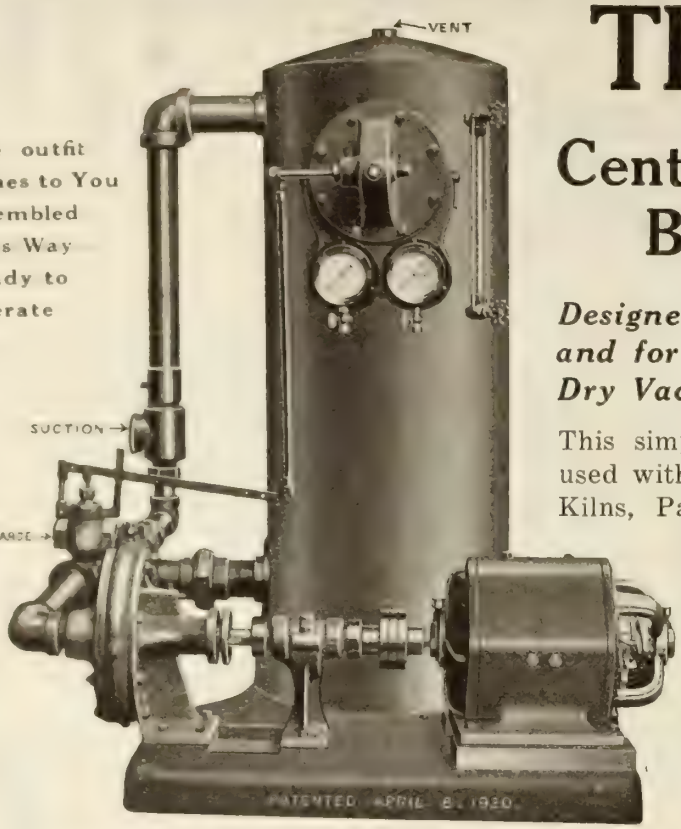
RILEY JONES
The UNDER-FEED STOKER COMPANY OF CANADA LTD.
MURPHY

The YOUNG

Centrifugal Vacuum and Boiler Feed Outfit

The outfit comes to You assembled This Way Ready to Operate



Designed for Vacuum Heating Systems and for All Conditions Where a Wet or Dry Vacuum is Desired—Highly Efficient

This simple, inexpensive and noiseless outfit is used with perfectly satisfactory results with Dry Kilns, Paper Driers, Feed Driers, Print Mills, Cooking Apparatus, Vacuum Pans, etc. for the purpose of effecting a saving by returning the condensate for boiler feed.

Manufactured in Canada by

Young Pump Co. of Canada

Room 310, Lister Building

HAMILTON, ONT.

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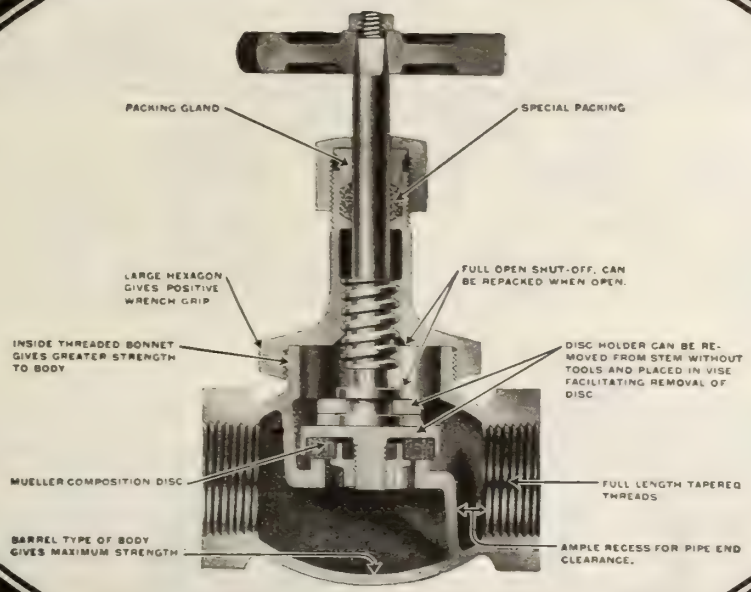
Remember, we are the makers of the famous 20th century shaking dumping Grate Bars.

The Boiler Repair and Grate Bar Co.

84 Church Street, TORONTO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SPECIAL PACKING
LARGE HEXAGON GIVES POSITIVE WRENCH GRIP
FULL OPEN SHUT-OFF, CAN BE REPACKED WHEN OPEN.
INSIDE THREADED BONNET GIVES GREATER STRENGTH TO BODY
DISC HOLDER CAN BE REMOVED FROM STEM WITHOUT TOOLS AND PLACED IN VISE FACILITATING REMOVAL OF DISC
MUELLER COMPOSITION DISC
FULL LENGTH TAPERED THREADS
BARREL TYPE OF BODY GIVES MAXIMUM STRENGTH
AMPLE RECESS FOR PIPE END CLEARANCE.

The Valve With Ten Points of Excellence

Compare the valve of any other make with this Mueller Steam Valve A-3006—test them—and note the result. This Mueller valve is a great achievement and has incorporated in its design all the up-to-date features experience has proved to be of value.

The ten good points of the Mueller A-3006 are shown in the above illustration. If you use valves, write and we will be pleased to send you a sample.

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Safety Water Columns

Reliance

Get the Most Out of Your Fuel

THE BOILER D. M. LIFE SAVER

Keeps your boiler clean and thus eliminates repair bills, besides reducing maintenance cost.

Will not injure boilers or fittings.

No acid — No chemicals — Just "D. M."

"D.M." Boiler Enamel is a Vegetable composition, absolutely harmless, and will keep your boilers clean right down to the bare metal. Prevents all scale formation, corrosion and pitting. "D. M." Boiler Enamel is used by many of the largest users of steam throughout the world, including the British Government.

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FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

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LESS FUEL, MORE HEAT

Always the COLE for COAL Economy

Economy and Efficiency

are both absolutely necessary to-day with coal mounting to almost prohibitive prices.

Cole Steam Traps

will save their cost many times over in your plant in a single season, through the saving in fuel, water, oil and worry. It is indestructible. It has no wearing parts, and is visible at all times.

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by using BETSON PLASTIC FIRE BRICK for repairs and for building complete, seamless, monolithic furnace linings, including front and rear arches, side walls, bridge walls and baffles.
No more fallen arches—no more in-leakage of cold air. But more power with less expense.
Shipped either mixed ready for use or dry to mix with water (the cost is the same) from warehouse stock in principal cities.
Write for valuable booklet.

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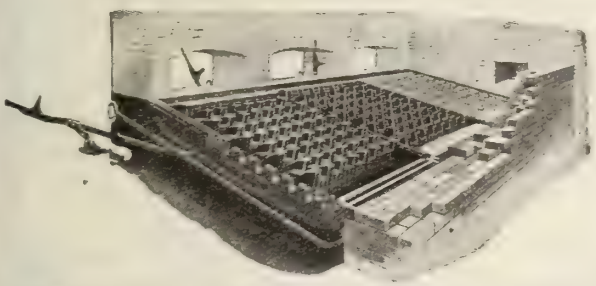
CoKal 'Chainless' Stokers

Self Cleaning *Hand Operated*



CoKal stokers can be furnished with or without hopper feeds

EASY TO OPERATE
INCREASE CAPACITY
ELIMINATE SMOKE
HIGH RATINGS
INCREASE EFFICIENCY
COST REASONABLE
SAVE COAL
INCREASE EVAPORATION
GUARANTEE RESULTS
UNIFORM FIRE BED
FIRES ALWAYS CLEAN
SOLVE BOILER PROBLEMS

The Best Hand Stoker Built

GELINAS & PENNOCK Reg'd.
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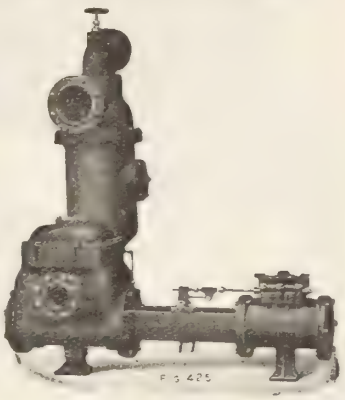
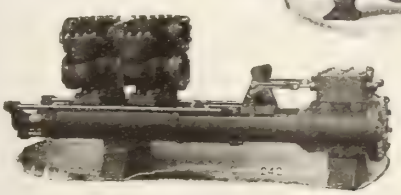
STEAM DRIVEN DUPLEX PUMPS POWER DRIVEN

The repeat orders received from a vast number of satisfied customers is proof that our machinery is right and that our guarantees have been covered.





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Power

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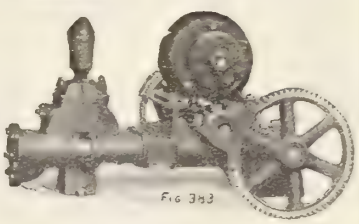

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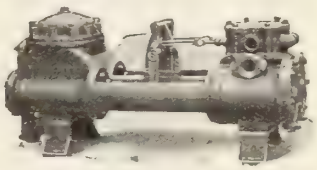
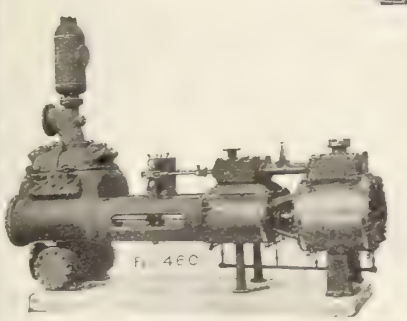
Triple Expansion





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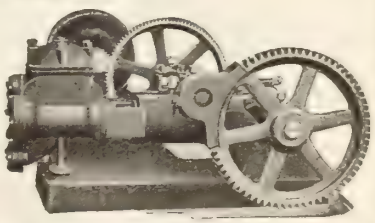
Packed Piston

Outside Center
Packed Plunger
Slide Valve

For All
Conditions
of Service



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at

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Dec. 7-13, 1922

(Except Sunday)

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Every Member of the A.S.M.E. and A.S.R.E. Should Attend

Fresh from the interesting discussions of the meetings they may go to the Grand Central Palace and inspect no less interesting exhibits of the latest developments in the power and mechanical engineering field.

The N. A. S. E. have fixed the following days for its gatherings: Friday, December 8th, New Jersey day; Saturday, December 9th, New England States and Connecticut day; Monday, December 11th, Greater New York day.

Representatives of the most progressive manufacturers of power plant appliances will be in attendance. Thousands of engineers from all parts of the country will visit the show.

Every facility for the convenience of visitors will be provided by the management, just as was done at the other expositions recently held here.

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Room 1102, Grand Central Palace
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FLEXIBLE METALLIC PACKING

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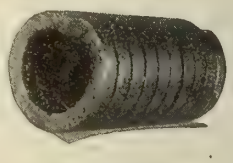
Babbitt foil impregnated with purest graphite and wrapped spirally. Flexible, uniform, compressible. Max. Temp. 450 F. Max Pist. Speed 400 F.P.M.



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Resilient asbestos channel with flexible metallic wearing face. Max. Steam 300 lbs.

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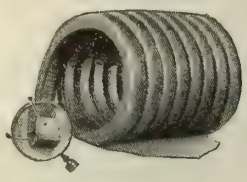
Resilient duck channel with flexible metallic wearing face. Max. steam 125 lbs. Max. Pist. Speed 400 F.P.M.



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are the more economical and more efficient means of dehydrating transformer oil or purifying lubricating oil for either Diesels or turbines. Strong centrifugal force, made more effective by the De Laval system of strata distribution, effects so positive a removal of water and solid impurities that the efficiency of oil is indefinitely maintained or restored by the use of these centrifugals.

Write for Bulletin No. 105, which gives full information regarding De Laval Oil Purifiers.

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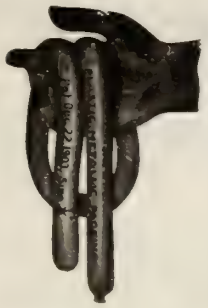

For steam, water, air, gas, etc., is practically indestructible and may be used over and over again. It is

GUARANTEED TO LAST THREE YEARS WITHOUT RENEWAL

It is made of an alloy of the finest anti-friction metals, just hard enough for long service but not hard enough to damage any rod.

The metal is combined with the best lubricating material, making it practically SELF-LUBRICATING AND FRICTIONLESS.

Send for full particulars also about our "Safety" Superheat Sheet Packing.

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Windsor *EST. 1899* Ontario
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INDICATING - RECORDING - CONTROLLING

Inspire that confidence that can only result from giving years of consistent accuracy as well as withstanding the strenuous industrial life for many years.

Tycos Temperature Instruments are accurate as well as rugged. They have been made that way for over seventy years. They will effect considerable economies on superheaters, condensers, and boilers.

Get our general industrial catalog. It is a real reference book for power operators.

Taylor Instrument Companies
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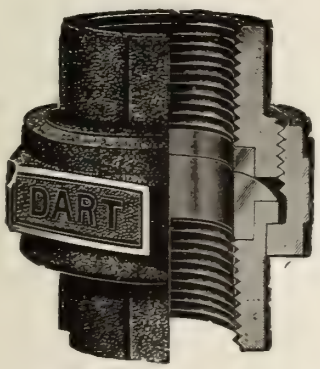
There's a Tycos or Taylor Temperature Instrument for Every Purpose

Your Jobber Handles
DART UNIONS



ALL DART UNIONS
HAVE A
Bronze to Bronze Ball Shaped Joint

Because of this feature, the Dart cannot deteriorate at the vital part, and is easily connected whether pipes are in or out of line.

MANUFACTURED BY
DART UNION CO., LTD.
TORONTO

A furnace is no better that its poorest joint

A RAGING blaze will find the joints between fine fire brick or poor fire brick with equal certainty; so a brick furnace of the best refractory is like a strong chain with one weak link. There is one furnace lining that always presents its full strength to the inferno of the furnace—

PLIBRICO JOINTLESS
FURNACE LINING

Plibrico is a superior refractory in the handiest form—unbaked, so that it may be molded and pounded into any required shape to suit any possible furnace requirement. It is then baked or vitrified in place, forming a rock-like, gas-tight, and, above all, a jointless refractory lining, resistant to temperatures ranging to 3100 F. Its form makes it universally adaptable; its quality makes it best for every purpose.

Plibrico is delivered only in steel containers of distinctive appearance as shown below. This container identifies the genuine Plibrico and keeps it in perfect condition.

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If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract. Readers are requested to advise the publishers regarding any equipment that they are buying and that is not listed.

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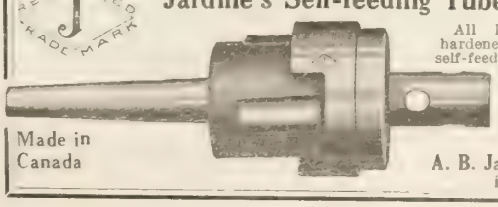
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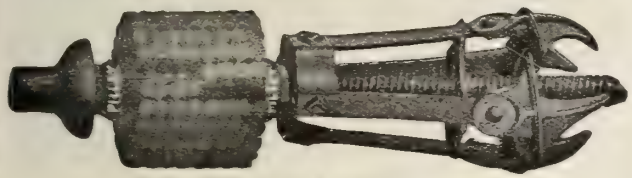

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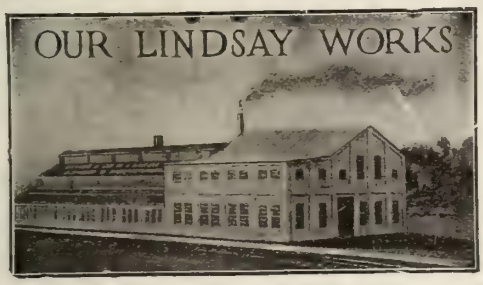

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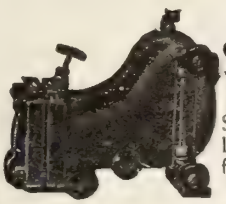

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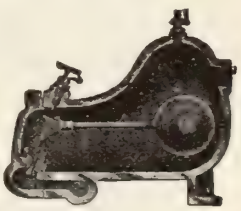

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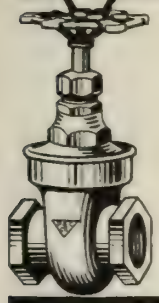

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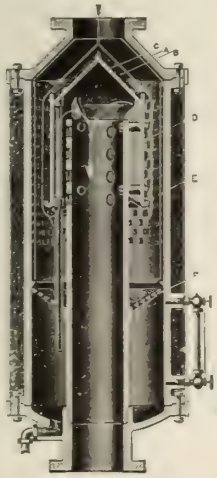

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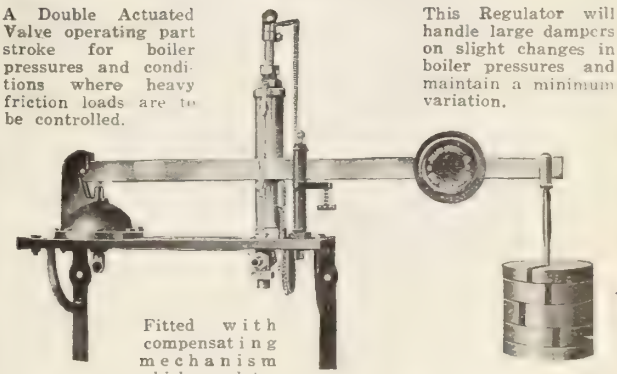

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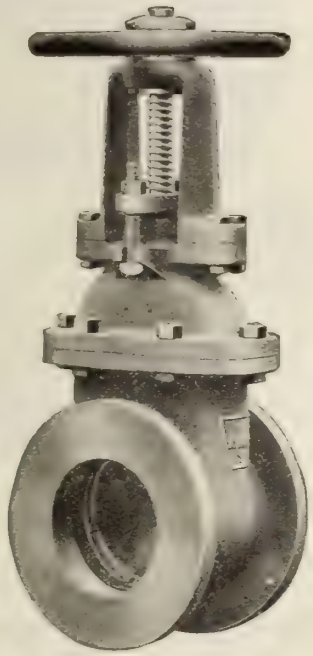

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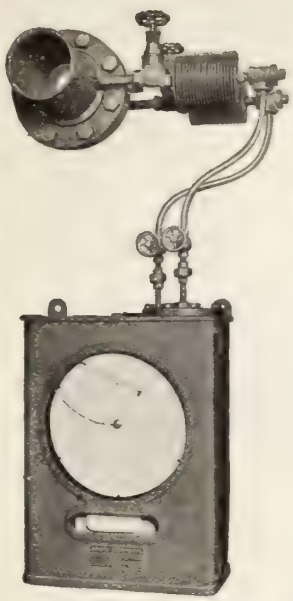

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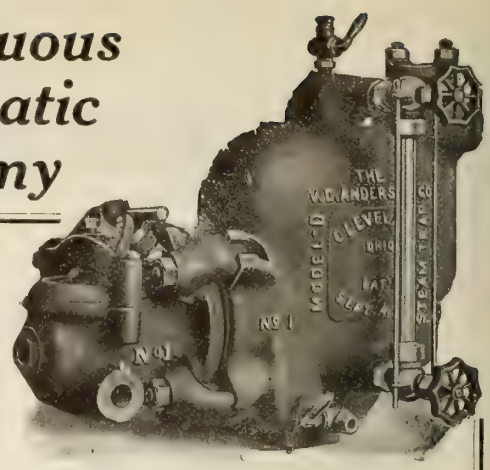

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Ensures Live Dry Hot Steam

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The sturdy, simple construction of the ANDERSON, together with the ease with which it can be changed to accommodate varying pressures, makes it the logical steam trap for this work.

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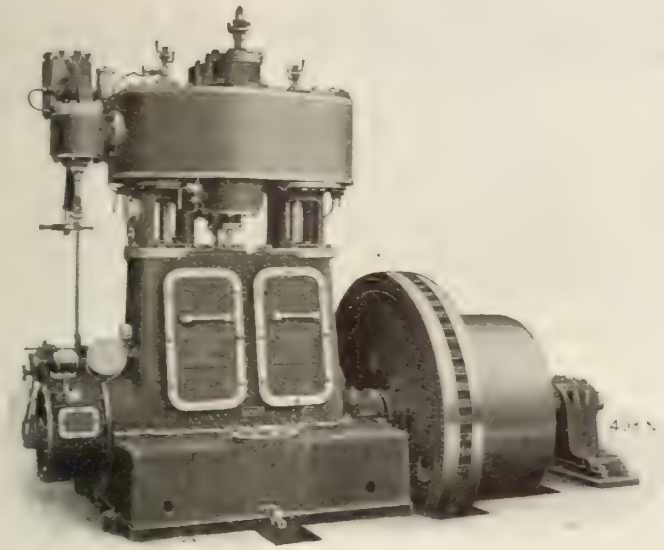

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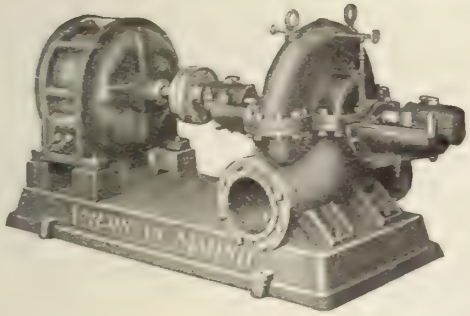

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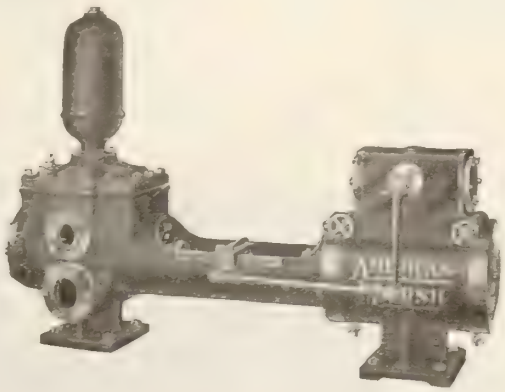

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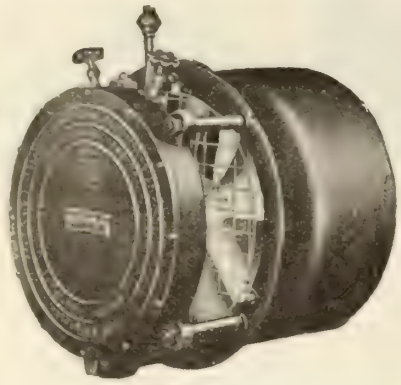

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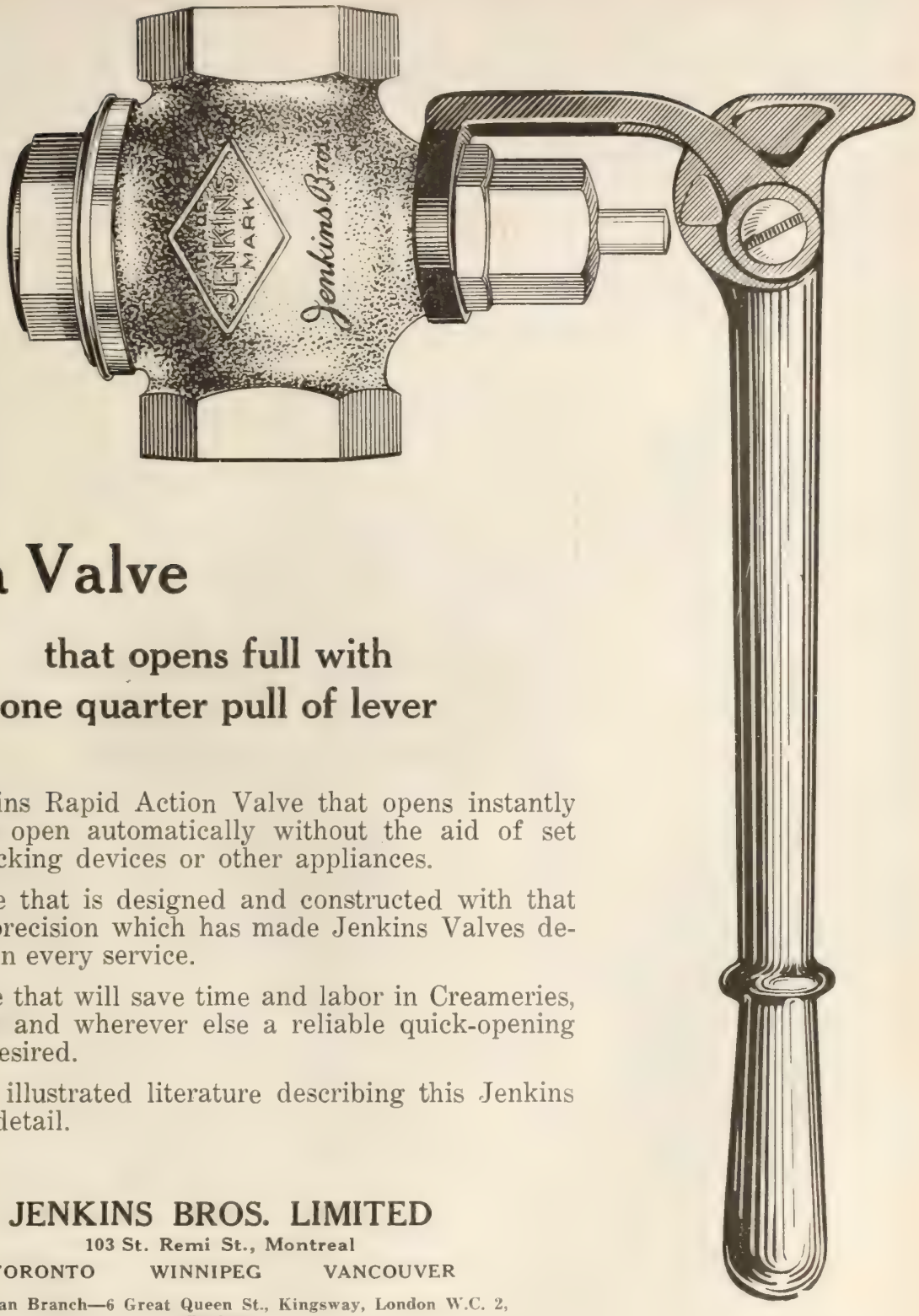

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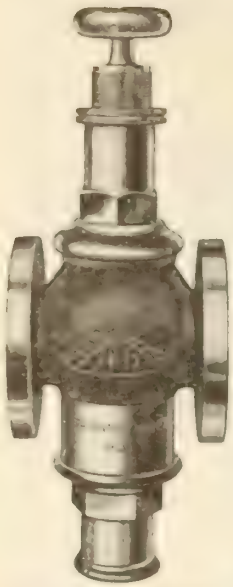

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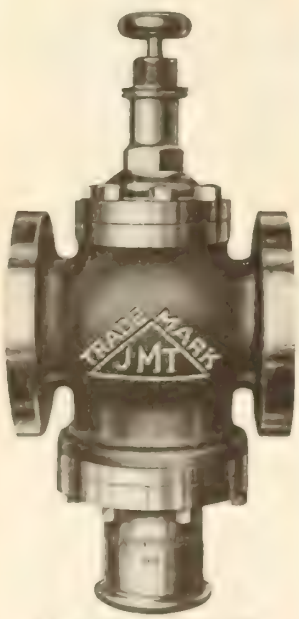

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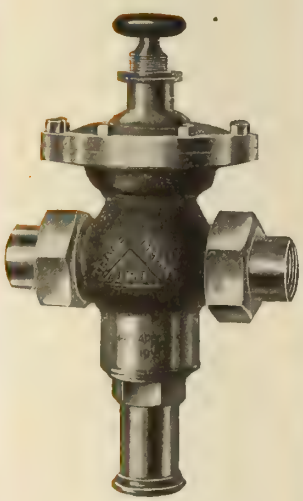

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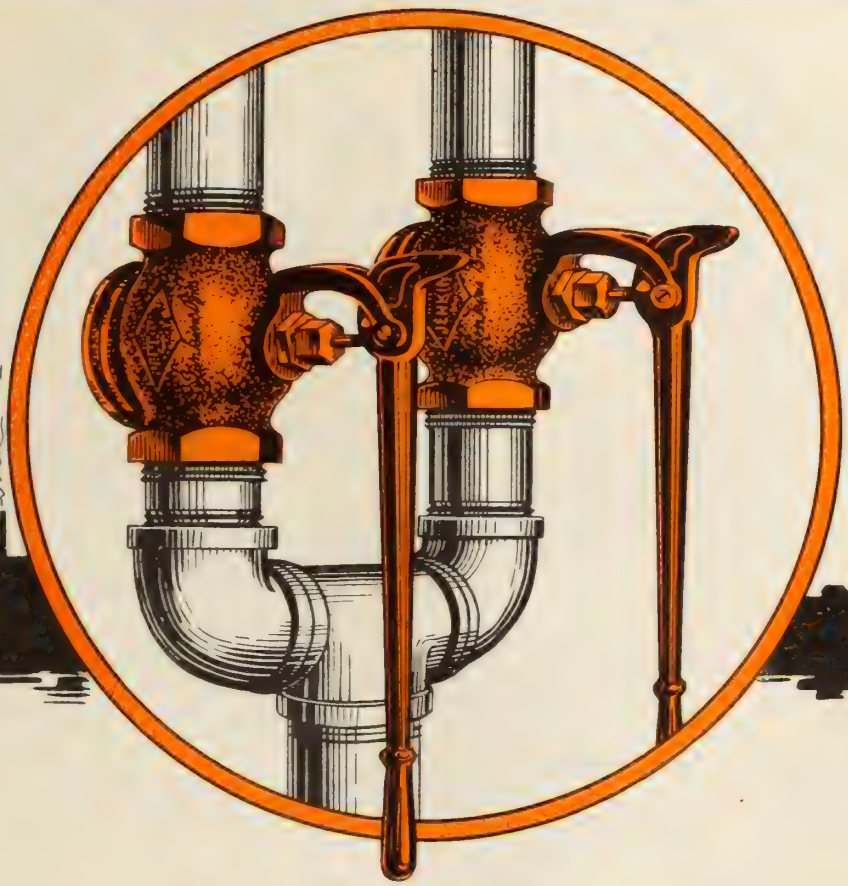

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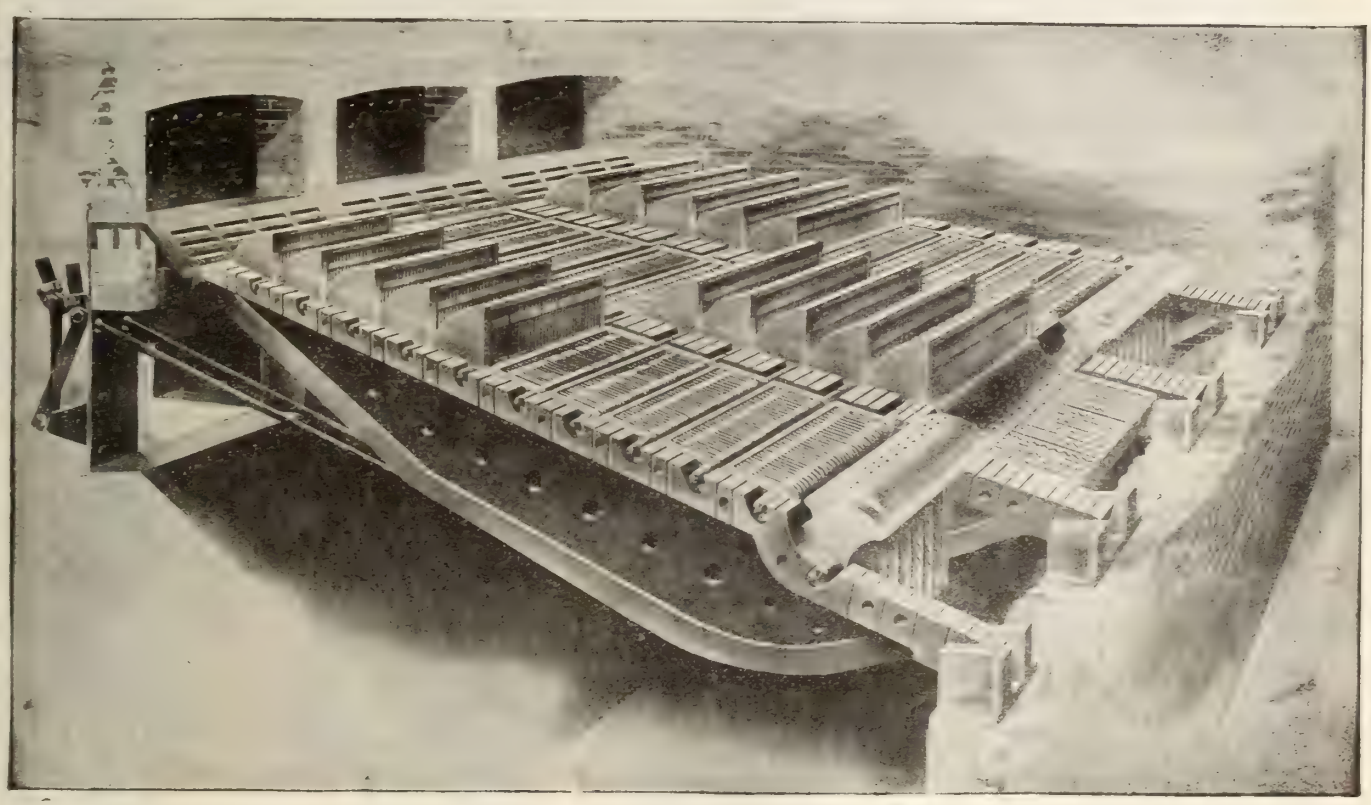

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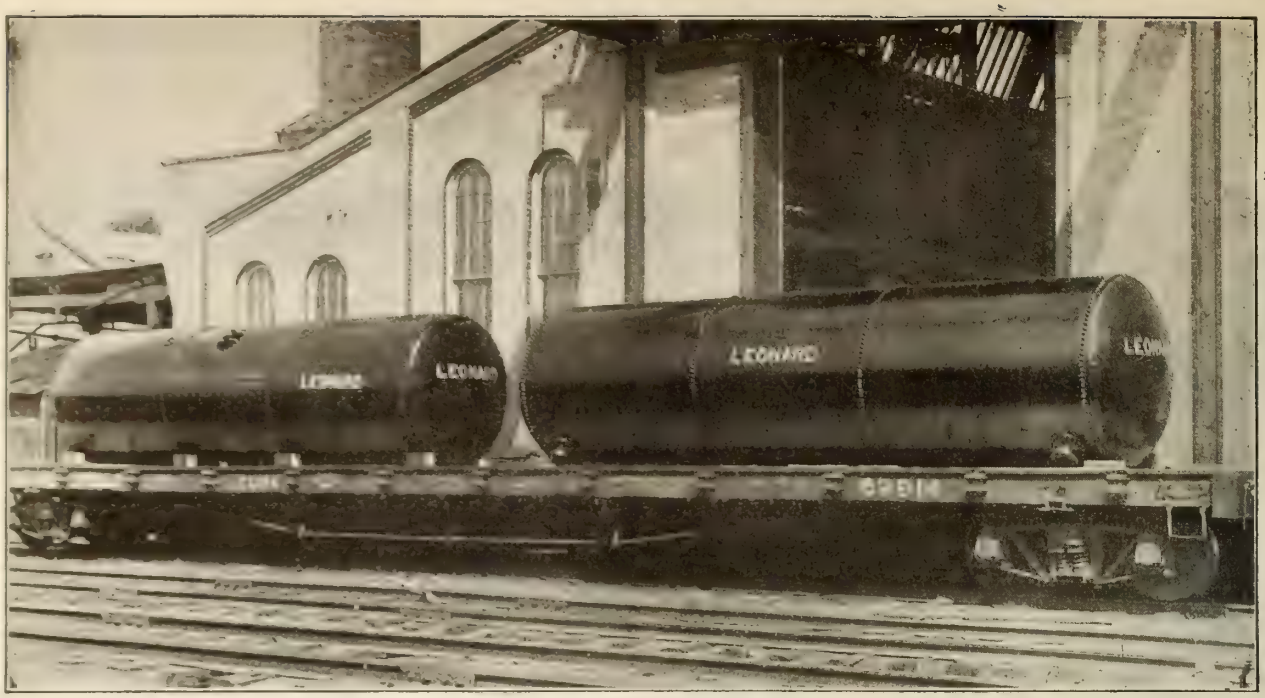

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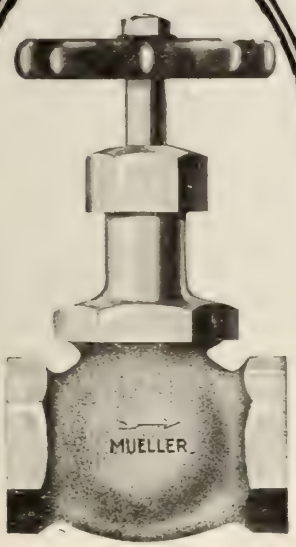

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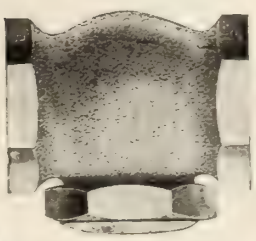
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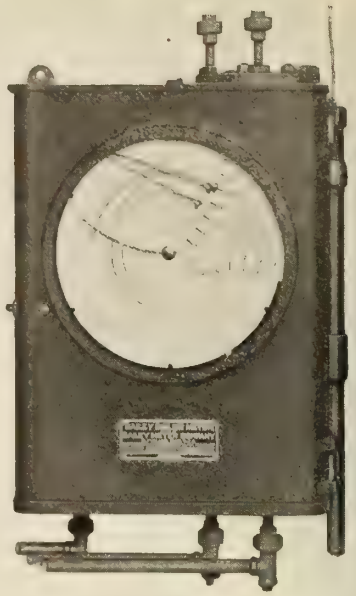

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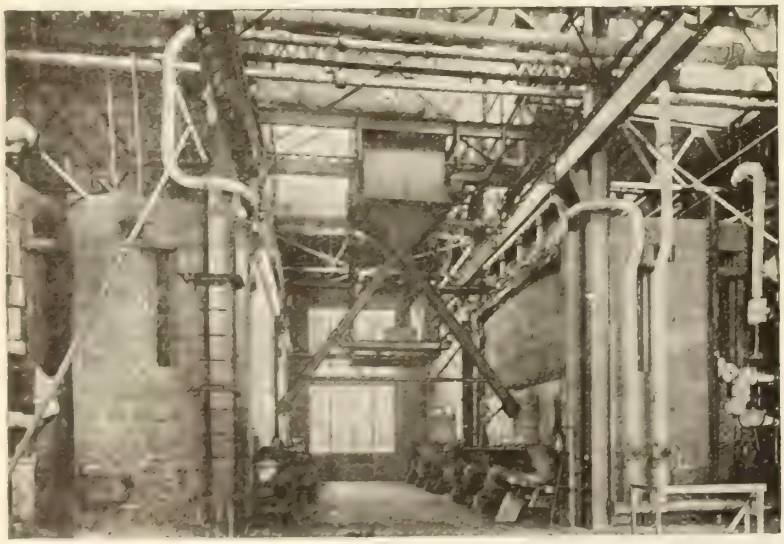

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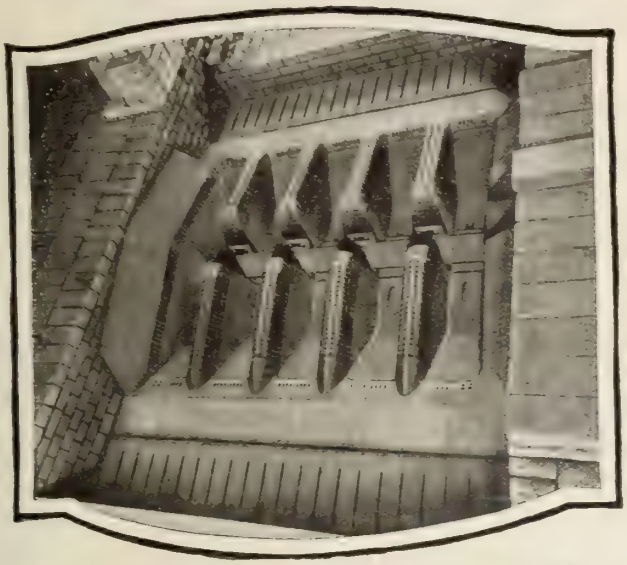

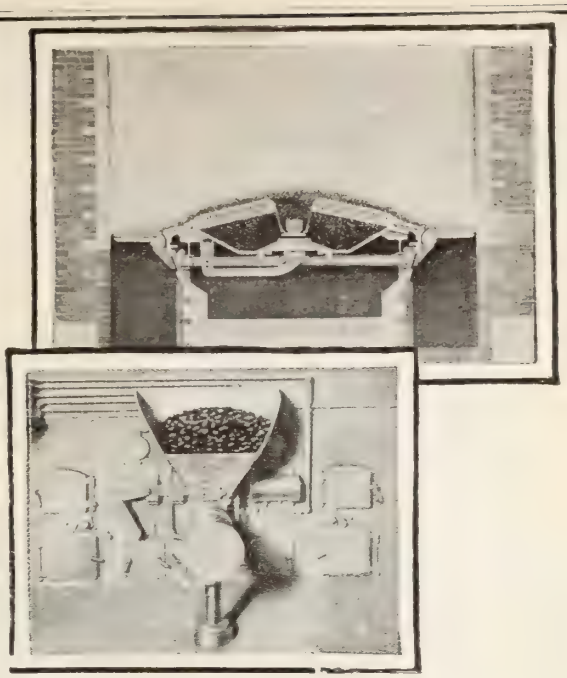

Multiplying retorts without multiplying moving parts

MULTIPLE retort stokers are not "sold on price." So apparent is the fuel economy of multiple retort stoking that stokers of this type have often been installed where special conditions made their installation cost much greater than the expense of other types of stokers. The greater first cost and installation expense have been justified by operating economies—but it is no longer necessary.

A new principle—the *"lateral retort"* construction—has made possible a *multiple retort effect in a side-cleaning stoker*. All the advantages of multiple retort stoking—high efficiency, flexibility and overload capacity—are found in the *"lateral retort"* stoker. Yet it is practically as simple and therefore as economically maintained as a side-cleaning stoker.

The views above illustrate the ingenious construction that makes greater economies possible. Coal is underfed to the central retort by successive strokes of a steam driven ram and pusher blocks. It is then *underfed* to the several lateral retorts by pusher rods and blocks operated by an ordinary steam cylinder. Throughout its travel the coal is underfed. At no time is it overfed onto side grates as in other side-cleaning stokers. Consequently the *"lateral retort"* stoker is the only entirely underfeed side-cleaning stoker yet devised.

Note the many advantages of the *"lateral retort"* principle explained opposite. These betterments are fully described in a new bulletin.

Advantages of the *"lateral retort"* principle

1. **Coal is underfed throughout**—not overfed onto side grates. This is the only truly **underfeed** side-cleaning stoker.
2. **One simple moving unit for five or more retorts**—The feeding mechanism of the lateral retorts is controlled independently of main feed, permitting ideal fuel distribution under all conditions.
3. **Simplest cleaning mechanism**—a perfectly balanced dump plate easily operated by hand.
4. **No need for basement ash pits**—A trench 6 to 18 inches below the floor line is sufficient excavation for ash pits. This greatly reduces installation cost and makes the stoker adaptable to boilers already in service.
5. **Plate tuyeres**—reduce siftings and lower replacement cost.
6. **High air cooled front and rear tuyere blocks**—keep fire and clinkers away from front wall and bridge wall, reducing furnace maintenance.

Under-feed Stoker Co. of Canada Ltd.
146 King Street West, Toronto

JONES STOKERS *RILEY STOKERS*
MURPHY AUTOMATIC FURNACES

Alta. and West Sask.: Mr. J. Twomey, Camrose, Alberta. **Man. and East Sask.:** W. W. Hicks & Co., 567 Banning St., Winnipeg. **British Columbia:** E. A. Earle, Limited, 846 Hastings St. W. Vancouver, B. C. **Quebec:** The Cleaton Co., (Canada), Ltd., 403 Southam Bldg., Montreal, Que.

RILEY JONES
The UNDER-FEED STOKER COMPANY OF CANADA LTD.
MURPHY

The "Lateral Retort" Stoker
TRADE MARK

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

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Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

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"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

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Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility

DOMINION BELTING CO., Ltd., Hamilton, Canada - **Quebec Branch: 51 Duluth Bldg., Montreal**

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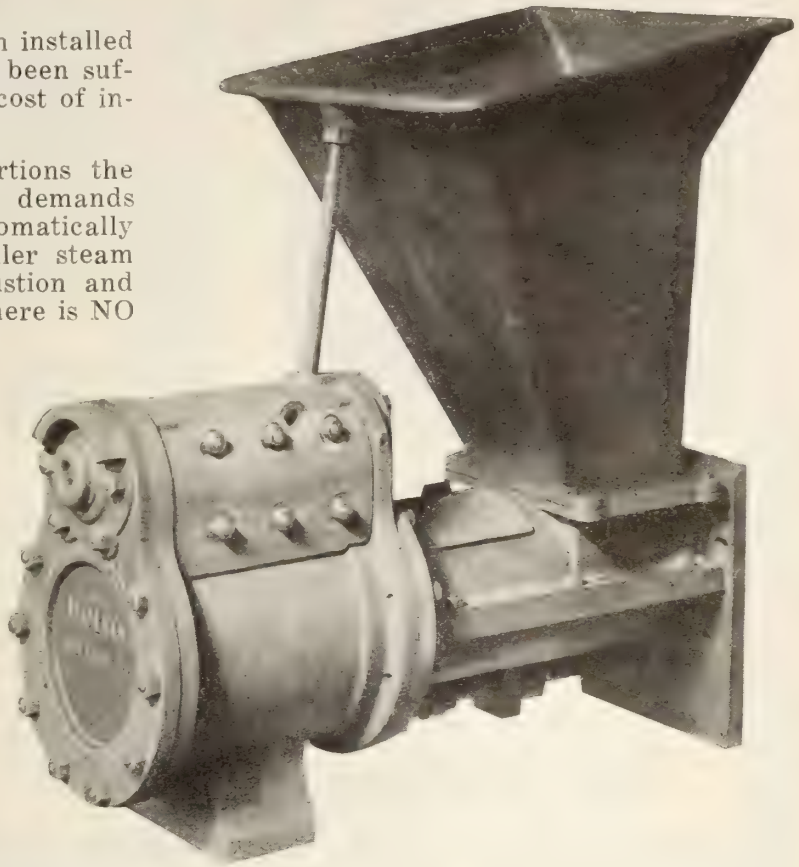
Wherever the MACLEAN STOKER has been installed the saving in both fuel and labor costs has been sufficient, in a very short time, to pay for the cost of installation.

The MACLEAN STOKER correctly proportions the coal feed and air supply to meet varying demands upon the boilers. These quantities are automatically controlled through the medium of the boiler steam pressure itself. It assures complete combustion and no matter what grade of soft coal is used there is NO SMOKE .



THE COAL IT SAVES
SOON PAYS ITS COST

Let us estimate the saving to be made in your plant

MacLean Underfeed Stoker Company
Limited
95-97 King Street East TORONTO

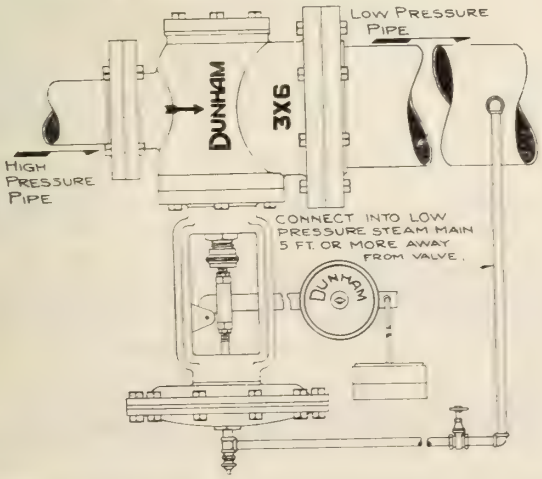
The DUNHAM HEATING SERVICE

REG. TRADE-MARK

(Made in Canada)

Reducing Pressure Valves

The Dunham Expanded Outlet Reducing Valve shown installed in horizontal steam main is especially designed for steam heating systems which require very low pressure. The expanded outlet permits quick steam expansion and facilitates reduction from high initial pressure to as low as atmospheric pressure.



Varying High Pressures Automatically Reduced to Constant Low Pressure

Dunham Reducing Pressure Valves insure an unvarying pressure on the low pressure side of the valves despite a considerable variation in pressures on the high pressure side. Steam, water or air is reduced to the desired pressure (atmosphere minimum) in one step without chattering.

Dunham Reducing Pressure Valves are applicable to a wide range of pressure service. An interchangeability of diaphragms which is permitted by standardized construction takes care of almost any pressure requirement.

Made in Straight and Expanded Outlet patterns. Finest materials and workmanship. Complete data on request.

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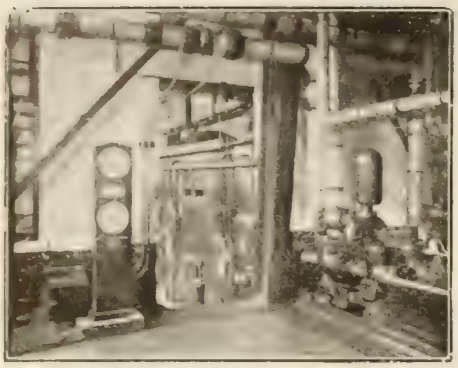
Also manufacturers of a popular line of heating specialties.

What is Going On In Your Boiler Plant?



With fuel both scarce and costly, this is the question many an owner is asking his Chief Engineer. It is an important business which is carried on in the boiler plant and must be given serious attention. Accurate information of the evaporation of water for the amount of fuel burned each day is essential.

The VENTURI Meter

"VENTURI" Registered.

is furnishing this information in thousands of boiler plants. Over twenty years of service has proved the Venturi to be supreme for boiler feed measurement. It has long since been accepted as the **Standard Meter** for the boiler room.

Bulletins 93 and 197 give details.

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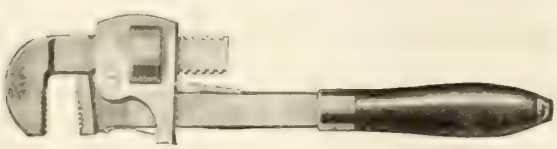

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Are sturdy and dependable—well balanced—positive in grip—powerful in action.

The tough teeth retain their sharpness; they "bite" instantly, yet release readily.

Wood and Steel Handle Patterns—eight sizes, 6 to 48 inches. Ask for booklet.

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PUMPING EQUIPMENT AT HAMILTON, ONT.

IN 1917 specifications were issued by the City of Hamilton, Ont., for a 10,000,000 gal. steam turbine driven centrifugal pumping unit and a 10,000,000 gal. electrically driven centrifugal pump, and contracts were ultimately signed for a De Laval geared steam turbine driven two stage centrifugal pump and a De Laval 10,000,000 gal. per day centrifugal pump driven by electric motor.

The motor driven pump, when tested, Feb. 5, 1920, delivered 10,028,571 Imperial gal. per 24 hours, against a total head of 299.92 ft. with a combined efficiency, including pump and motor, of 75.98% and a pump efficiency of 80.4%. The guaranteed pump efficiency was 77%.

The steam turbine driven pump, when tested on Oct. 30, 1920, was found to deliver 11,110,000 Imperial gal. per 24 hours, against a total head of 310.4 ft., using steam at 169.7 lbs. gauge pressure. Reduced to standard steam conditions, this amounted to 117,000,000 ft. lbs. per 1,000 lbs. of dry steam, without giving credit to the unit for the heat returned to the boilers by vacuum and boiler feed pump exhaust to an open heater. The guaranteed duty was exceeded by 2.8 M.F.P.

The steam turbine driven centrifugal pump is not only practically equal in overall efficiency to the best reciprocating pumping engines, but costs much less for buildings and foundations and is less expensive for attendance and upkeep, including repairs and lubrication. It represents the most economical method of handling water.

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Steam Turbine Co.

TRENTON, N.J.

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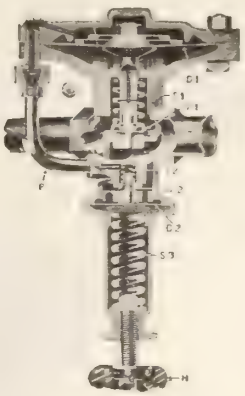

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Coal costs are sky-rocketing. Rigorous coal economy is absolutely essential—this year more than ever.

Steam must be carefully handled—all possible value must be utilized.

Equip your plant with

FISHER
PRESSURE REGULATOR
(Series 90)

And you have gone far to accomplish that desired goal—steam efficiency.

Use this valve wherever you desire an accurately gauged supply of reduced steam pressure. Fisher Pressure Regulator is noted for its reliability—long-lasting accuracy.

It also shuts off absolutely tight when low pressure consumption is stopped. Pressure will not build up on low pressure side.

The ever-increasing popularity of Fisher Specialties is gained through their excellence. A well-knit organization of happy workmen puts forth its best efforts to make each Fisher Specialty mechanically perfect. They are experts in their work.

Write for interesting literature about the Fisher Pressure Regulator. It is yours—with our compliments.

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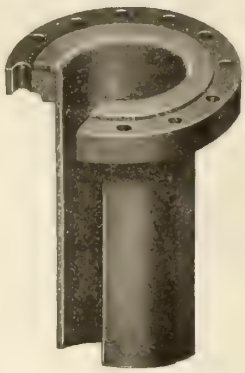
Agencies in all principal cities

P⊕H FLANGED PIPE JOINTS

SCREWED



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SCREWED FLANGES.—For general service, our screwed-on flange gives universal satisfaction and is the least expensive. For steam and water lines, at pressures up to 125 lbs., the flange is screwed home and not refaced. For higher pressure, we recommend screwing on the flange until the end of the pipe projects beyond the face, then refacing by taking a cut across the flange and end of pipe, insuring a perfect joint with the gasket bearing on the end of the pipe. This prevents the pressure from working through the thread of the flange, and insures a long life for the joint.

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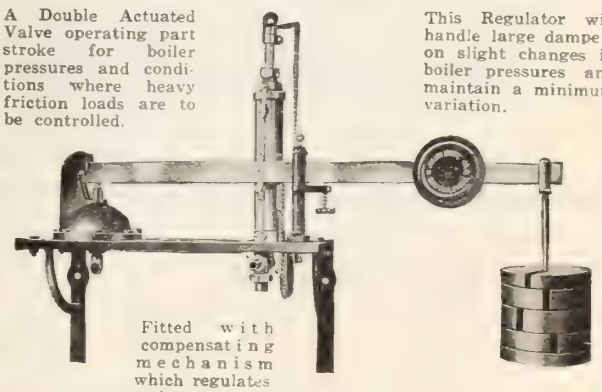

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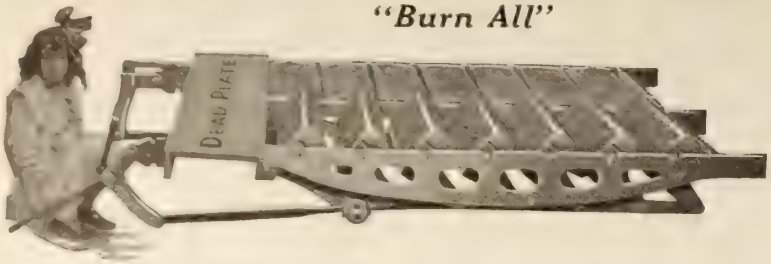

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The W. R. SEXTON Boiler Setting Co.

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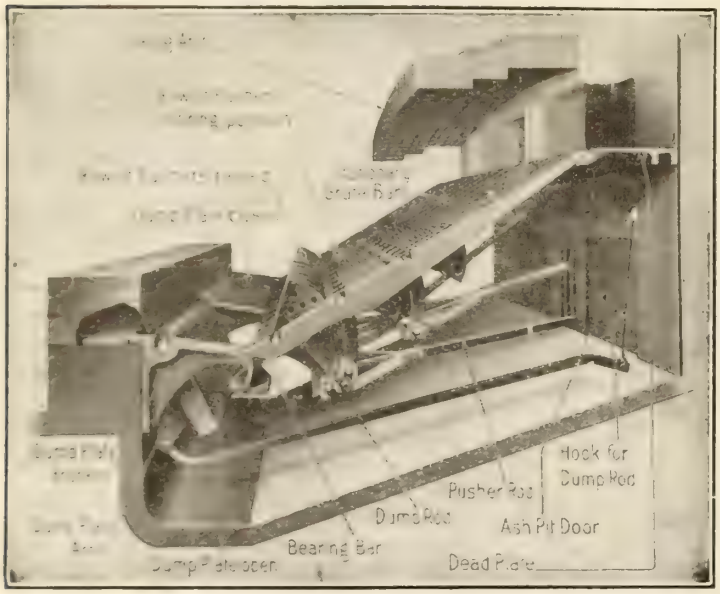
You need the National Hand Fired Stoker



Get away from inefficient hand stoking—without going in for costly mechanical stokers—come in between with the National Hand Fired Stoker which any "green" furnace man can be quickly taught to understand. Pusher rods at front of furnace operate successive banks of Pusher Grates, keeping the fuel moving downward—finally to the Dump Grates. Ensure proper progressive combustion. Any type of fuel—even waste—can be used. No smoke. No fuel in combustion chamber. No ashes in flues. Increased boiler capacity can be demonstrated. Can be installed under your present boilers.

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Will not injure boilers or fittings.

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"D.M." Boiler Compound is a Vegetable composition, absolutely harmless, and will keep your boilers clean right down to the bare metal. Prevents all scale formation, corrosion and pitting. "D.M." Boiler Compound is used by many of the largest users of steam throughout the world including the British Government.

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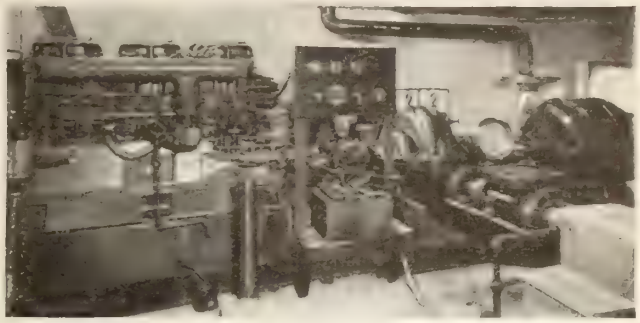

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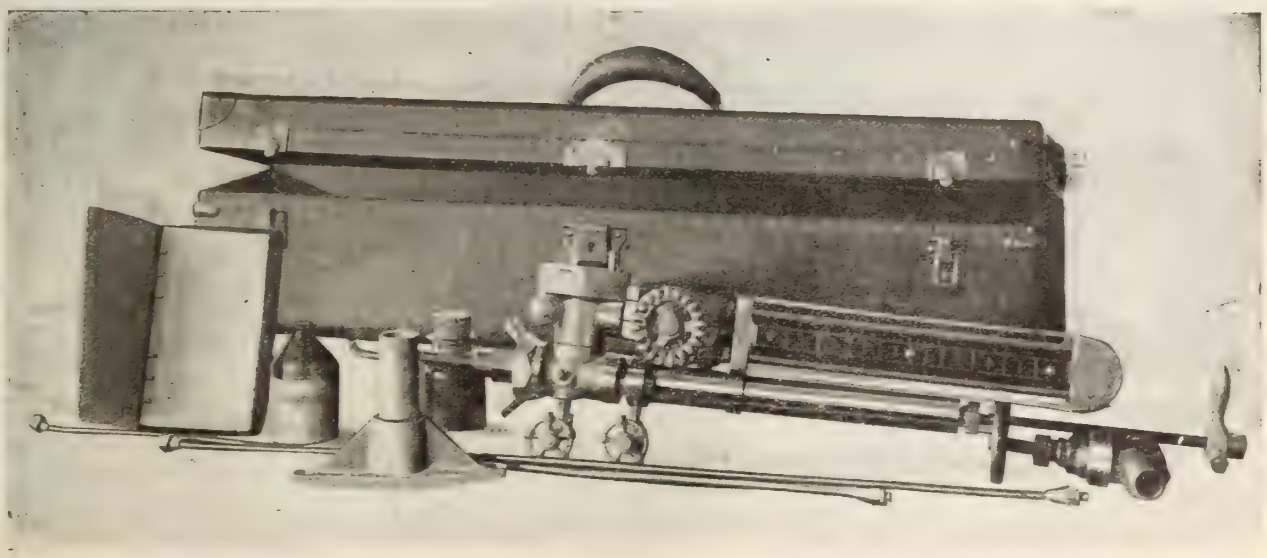

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National Exposition of Power and Mechanical Engineering

Grand Central Palace, New York City

Room 1102

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A Sarco operates on gas, steam or hot water heat. Can be supplied to control temperature in most any kind of manufacturing process—including the most delicate. Also controls room temperature.

Write us about your particular problems of temperature control and our engineers will be glad to make recommendations for obtaining a better product, an increase in production, or lowering manufacturing costs.

Sarco Regulators are sent on 30 days' free trial to prove their adaptability. If not satisfactory the regulator may be returned and the trial costs you nothing. Booklet J-73 contains interesting information. Write for it.

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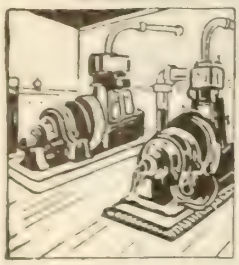

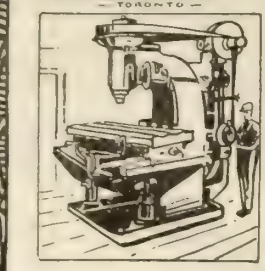

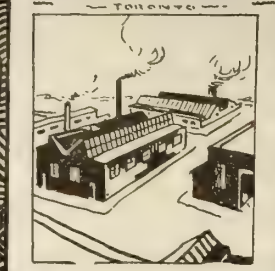

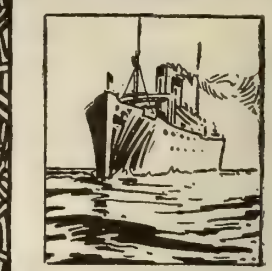

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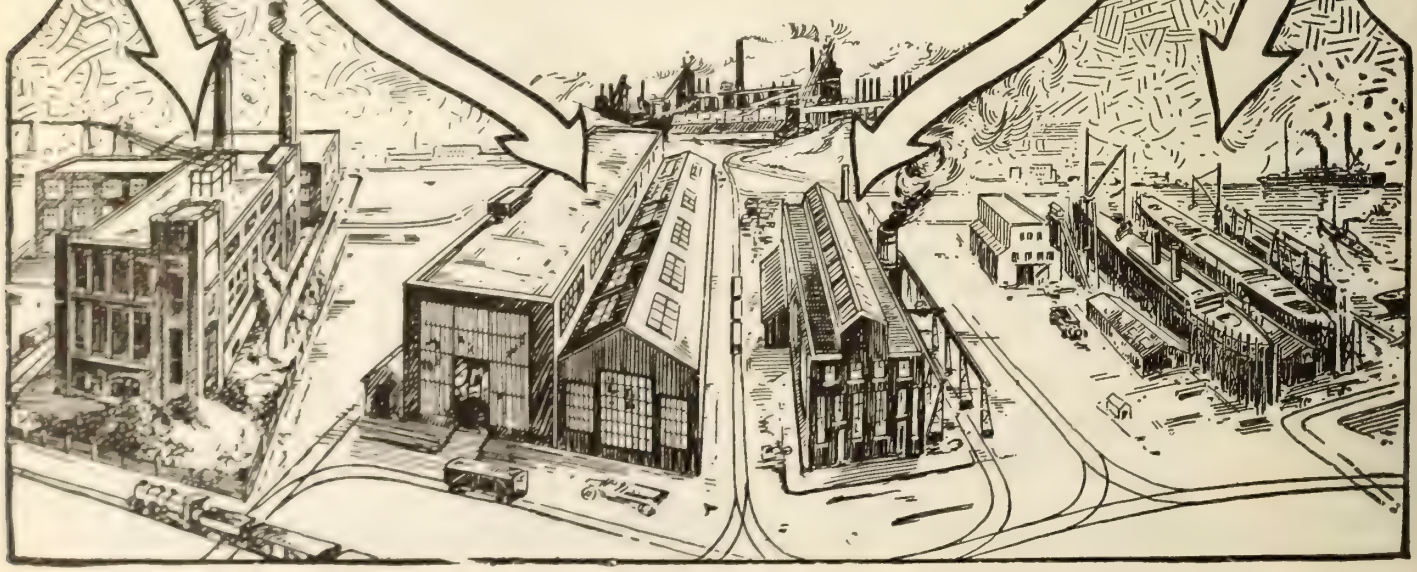

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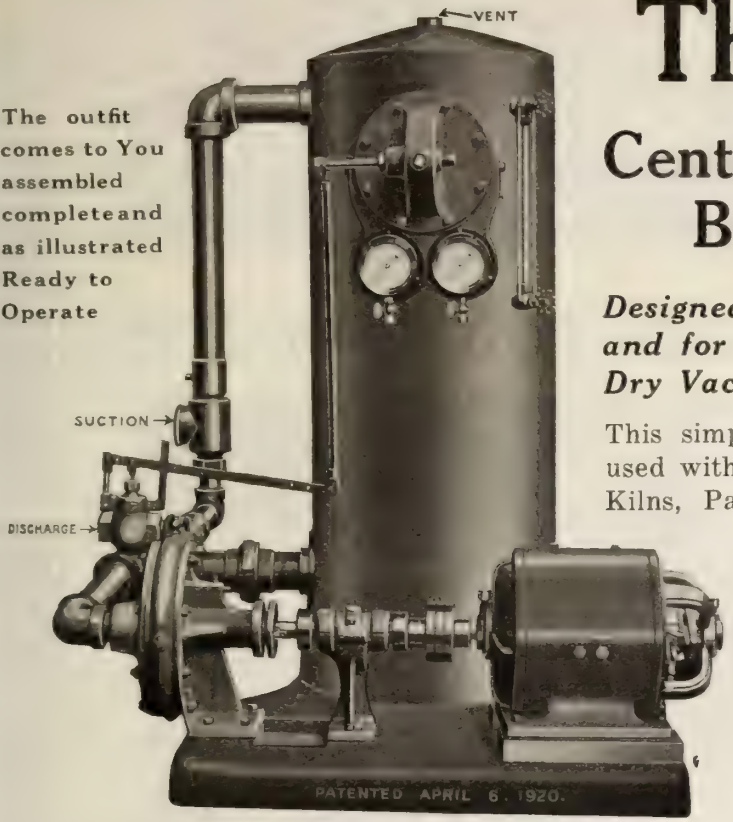

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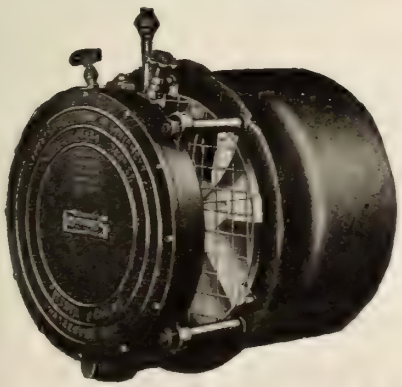

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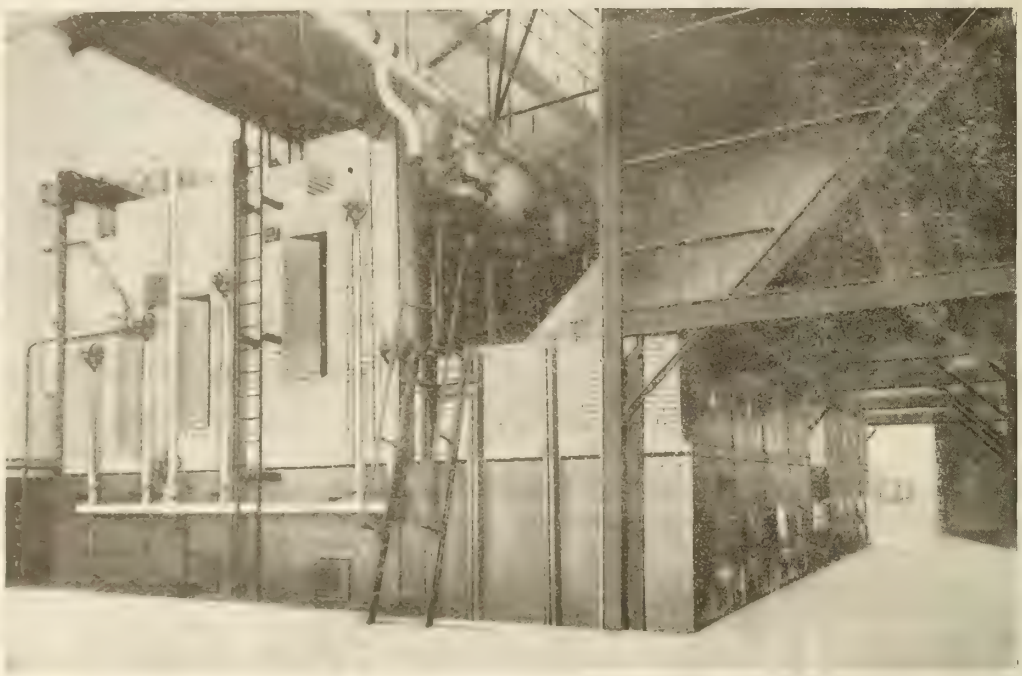

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The Power Plant Journal of Canada

Published in Toronto

Established 1907
Published Semi-Monthly

Possibilities of the Power Plant Engineer

From the Starting Point of His Career to the Ultimate Goal an Engineer's Life is a Hard One, Mentally and Physically—Can it be Made More Worth While?

By T. H. FENNER, A.M.E.I.C.

EVERY man that starts a career as stationary engineer, does so with the idea that at some future time he will have a position which will give him a good living, the respect of the community in which he lives, and at least as much leisure as comes to the average citizen. We do not include, of course, those who take up work around a steam power plant as a means of filling in a gap when things in their own special line of endeavour are dull. These men as a matter of course fill the lower positions for a time, and then drift away. We have in mind chiefly the man who starts in as a young man, with the intention of rising to the position of chief engineer or mechanical superintendent of a large manufacturing industry, or perhaps a central power plant.

To such a man the stationary engineering or power plant engineering field presents much better opportunities to-day than it did a few years ago in Canada, but at the same time it demands considerably more from him. The earlier stages of the game are hard and exacting, and it is difficult perhaps to visualise the higher peaks attainable. It demands constant vigilance, attention to duty, and many hours spent in making up educational lapses when off duty.

The question which every young man must ask himself is, whether he has the capacity for sticking, enough liking for the business to make it attractive, and whether the ultimate reward is as great as he could obtain in any other line of endeavour. It may be granted off hand that it is only the exceptional man who does not realize that nothing is attained without hard work, but at the same time, no one wants to spend years of hard work in a field that is uncongenial and has nothing in the way of return to offer commensurate with the endeavor expended.

An Improved Status

There is no doubt but that the status of the power plant engineer is higher to-day than it has ever been, and it is beginning to be realised that the qualities required of the man in charge of the plant are just as high as the qualities demanded from any other manager of a department. The Governments of the various provinces are calling for a much higher technical standing than they ever did before, and that is naturally improving the class of man who is making stationary engineering his life work. Plants are more valuable, the ability of the engineer to operate them in an efficient manner is more important, and the tools given him to effect this operation are more costly in character, and their proper use demands skill and attention. On the other side of the case it has to be admitted that the factory manager, and owner, speaking generally, has not realised as he should all that is required from the engineer, and he has not made the position as attractive from a monetary standard as he might have done. That is a condition which will undoubtedly be remedied as time goes on, and the engineer begins to realise his true place in the industrial community.

The Engineer's Duties

The duties of an engineer in a modern manufacturing plant are many and various, ranging from the work of the man who fires a boiler and looks after a small engine, to that of the man who has a complicated plant containing a large variety of machinery and testing instruments, including electric generating apparatus, refrigerating machines, air compressors, and conveying machinery. One represents the lowest end of the scale, the other the highest, but there are many in between. Take for instance a large office building or institution where there may be no generating apparatus at all, but where the heating and ventilating equipment comprises a huge investment, and which must be run just exactly right if the tenants, who represent the revenue, are to be satisfied. The engineer in a building of this kind has not only to look after all this equipment, but in addition oversee the operation and maintenance of elevators, and not infrequently has to supervise the general maintenance of the building, such as painting, carpentering, roofing, and plumbing. This represents another point on the scale of an engineer's duties. The modern hotel is a good instance of the all round ability a man has to display who has charge of the mechanical end of it, for there is practically every kind of apparatus known to steam engineering science included in the power plant of such a building.

The road a man has to tread before he can hope to be in charge of any such plants as we have spoken of is a hard one. Let us see briefly what he has to face from the time he starts in as a fireman or oiler in any kind of a plant, until the day when he is put in charge of a real big installation, and has the opportunity to prove that his previous years have been well spent.

There are and always will be a large number of men who start in as firemen, and will remain as firemen all their lives, because human nature is so constituted, and two men starting equally at the bottom of the ladder will have very different rates of progress, depending on their temperament and ability. We say temperament and ability, because it often happens that a man with considerable ability is handicapped by a temperament or outlook on life, which continually prevents him from realizing on the capabilities that are in him. However we are taking the case of a man that means to rise, but knows well that there is no royal road to advancement, but merely a highway strewn with many obstacles, that have to be surmounted slowly and sometimes painfully. We do not consider here the man with a University education, because it is not usual for him to adopt stationary engineering for a profession, although he may go into stationary plants for a while to gain that practical experience which is necessary for him to properly apply his knowledge. Our hypothetical engineer will then spend some months at the laborious work of firing a steam boiler, cleaning fires as a matter of course, spending Sundays occasionally inside of the boiler when its cleaning time comes around, and making himself generally useful.

He can be absorbing a lot of practical knowledge about boiler operation during this time and, if he is of the right sort, he will be continually asking questions of the chief or second, or the boiler room foreman if the plant is a large one. His probationary time as a fireman may spread into one or two years, according as opportunity arises. After he once becomes thoroughly acquainted with the manner of handling the job he is in, and has more than a nodding acquaintance with the various apparatus in the boiler room, he will begin to look for advancement in the plant he is working in, and failing that he will look for a job in another and larger plant. Before he gives up the boiler room completely he should try and gain some experience with the handling of some of the mechanical stokers that are on the market. If at the time he starts in at firing his educational equipment is not good, he should start right in to improve it in his spare moments, realising that without a fair equipment mathematically he cannot go very far. There is to-day quite a number of places where he can get this education, either by personal tuition, or by correspondence. If he has the ordinary high school education he can start right in on his engineering education, either in technical school, or by correspondence, or merely by reading good engineering books. Always he must ask questions, even to the extent of making himself a nuisance. He will on occasion be steered wrong, but a man with his eyes open and a real desire to learn will not be very often misled. There are those who will try and mislead him, but they are the exceptions.

His next step will be to get into an engine room. Here of course as always he will have to take whatever opportunities arise, but he should try and get into as large a plant as possible, no matter in how lowly a position he may have to start. If he gets in as an oiler, he will have an opportunity of seeing just how the daily work is carried on, and also the privilege of helping the engineer or engineers in overhauling the various machines which the plant contains. He will learn to pack a pump, renew valves, adjust pump valves, tighten up the bearings of engines, adjust lubricators, etc., all of which is necessary to his training, and can be acquired in no other way than by actual experience. The plant will no doubt contain generators, either direct or alternating current, and he will see these machines functioning, and his enquiring mind will start him wondering as to just what makes them perform the work they are doing. He will enquire, and get whatever knowledge is available from the men on the plant. In addition to this he will turn to his books, and having the practical application in his mind's eye, will be better able to follow and understand the printed word. He will contemplate the switchboard with a new interest and will not be content with knowing that a certain switch has to be thrown in under certain conditions, but will try to find out why. He will look on the maze of connections at the back of the board and at odd times will amuse and interest himself with tracing out the various wires and busbars and understanding their connection with the switches at the front of the board.

All this will take time, and we may imagine him as now having been some months in the plant, and getting charge of a shift on his own account. Now at last he will be beginning to realise what responsibility means. He may only have charge of the engine room, and another man have charge of the boiler room, or he may have both under his care. If the plant is one that runs in shifts we would advise our young engineer to try and get charge of the boiler room shift in preference to the engine room. It is the boiler room that demands most of a man when all is said and done, and it is the part of the plant where a man can show the results of his training in a more pointed way than he can in the engine room. His job will not merely be to keep steam, but to keep it with the least expenditure of coal. To do this he will have to understand furnace efficiency, and if the job is a mechanical-stokered one, he will have to thoroughly understand the type that is fitted, while if it is a hand fired plant, he will have to remember his own experiences as a fireman, and apply them to handling the boiler room crew.

This matter of handling men is the hardest thing in the world to learn. It is not born in a man, but is a thing that must be learned, if success in big positions is looked for. It requires firmness and tact, the ability to make a decision and stick to it, and at the same time a considerable degree of sympathy and allowance for the weaknesses of humanity. Every man cannot acquire it, but no man can achieve success without it.

Further Experience

After the job as charge man on a shift in the boiler room, a shift in the engine room should be taken on, if possible. Here the chief quality required will be unceasing vigilance, and an appreciation of what small changes in operating conditions can mean. The rod that does not look quite right must be carefully watched and the right remedy applied, while the mysterious click that develops somewhere else must be traced to its source, and either eliminated there and then, or reported upon in such a manner that it can be remedied when opportunity arises. It is not the writer's intention to try to define the actual duties of a man in such a position, but rather to lay out a course which should be followed if possible in order to turn out the finished engineer. It is understood that all this time the work of education is being carried on steadily and industriously, and the rising engineer is not only becoming familiar with operation, but is getting such a knowledge of the principles of the machines he is working that their operation becomes so much more interesting. It is, of course, realized that every man cannot get into plants where he will have these opportunities, but what is particularly to be impressed is this, that it is of no good staying in a job that is a blind alley after all has been learned that the job has to offer. Get a new job in a different type of plant if not a bigger one, but always remember that what is required is not only length of experience, but diversity of experience. There is so much apparatus connected with the modern power plant and so many different types of equipment that it is only by moving around from time to time that it is possible to become acquainted with a reasonable amount of it.

It may take from three to four years, or even five, depending on the success met with in obtaining the kind of jobs wanted before a man feels competent to take absolute charge of a medium-sized plant. From this time on, progress is a matter of making good. Success in the first plant taken charge of will give a good lever to use in applying for the position that is a little better, and success in the first important job will depend on the use that has been made of the years preceding this job.

The Finished Product

We have reviewed in a general way the progress of the engineer from the bottom of the ladder to a position on the higher rungs, and we have outlined some of the experience he has to go through to get there. We will suppose that he goes on getting charge of larger plants from time to time until he arrives at a position where he can count himself fairly successful. What will he be by then? He will be a man who understands very clearly the natural principles governing the application of heat to the generation of power, and to that extent will be a scientific man. He will, besides that, have a wide experience in the application of those principles to the demands of modern industry, including, in most cases, the application of heat to produce cold, or refrigerating practice. He will understand also the economical operation and maintenance of all the different machinery, from the coal conveyor to the switchboard, and the intelligent use of all the different testing instruments in use to ensure efficiency of operation. He will be a man with executive ability, and should really know enough about modern cost accounting to see that the cost department does not put down charges against his department that properly belong to others. He should also know enough about investment costs and fixed charges to be able to advise intelligently on the subject of new equipment, and the scrapping of obsolete apparatus in favor of modern.

This progress upward which we have sketched in so lightly will have taken anywhere from ten to twenty years, and, of course, there are many men who are longer than that at the business before

getting anything worth while, and there are also some others who never achieve anything but the most moderate positions. Granted that a man has achieved success as we measure it by ability and opportunity, the question is, what will he get for his years of working up? What is his financial status?

Rewards Not Commensurate

There can be no doubt that as things stand at present the salaries obtainable are, except in a few cases, not as good as they should be. We may say that the average wages that can be earned by an engineer in charge of a small plant do not much exceed $30 per week, while the man in charge of a large plant who is getting over $50 is an exception. In taking these figures we are speaking of averages, which, after all, is what should govern. We know of one or two cases where the master mechanic of a large building, having charge of not only the power plant but all the maintenance of the whole building, is receiving $300 per month. That is, after all, not too high when the responsibilities of the position are considered. As we have pointed out, a man is not fit for one of these positions until after many years of hard, laborious work both of the mind and the body, and work performed at all hours of the day and night, for long stretches at a time. In every case, after he gets chief of any kind of a plant, he is expected to be at the end of a telephone night and day, in case of emergency. His training is a hard one; his knowledge gathered over many years is, or should be, wide. The man on the business side of the house, who may not have anything like the ability the engineer possesses, is, nevertheless, doing work which is productive from the management's point of view. He, therefore, attains a high salary much earlier and with much less effort than does the engineer, and has an ultimate possibility of reward far exceeding that of the man on the mechanical end. This has always been true, and is not only true in mechanical engineering, or steam plant engineering, but in any other line of engineering. The answer would seem to be, don't be an engineer, be a business man.

What To Do

The remedy would seem to be, as in all these cases, in organization. Now the writer does not for one moment mean organization such as is given by unions. To the engineer the trade union is probably the worst thing that could happen, because nothing will tend to deaden his initiative and ambition so much as the tenets of unionism. The organization that is needed is organization along the lines of a professional engineering society, with definite standards of qualification for membership, and an ideal to aim at. The C. A. S. E., for instance, has been in existence for over thirty years, and has woefully failed to do anything at all worth while on those lines, and at the present moment is in a precarious position in some ways. There has been a lack somewhere, and while some say it has been the leadership that has failed, others say that the membership never took enough interest to make it go.

As we said at the beginning of this article, the qualities demanded in the engineer are getting higher all the time. The examinations for certificates are getting stiffer gradually, and will continue to do so year by year. A new generation of engineers is growing up. Now is the time to try and set them on a proper footing so that they can build from the ground up.

If a word of suggestion might be offered, it is this. The first aim of a society of stationary engineers should be quality and not quantity. There are enough men at the business at present with high abilities to form the nucleus of an organization that would grow to be something worth while. Give the men without these qualifications something to aim at so that they will know that when they are eligible for admission they are being admitted to something that will put a seal of ability on them.

From the point of view of material change there is this to say. When a plant owner calls in a consulting engineer, he does so reposing full confidence in the man he chooses, and this confidence arises from the fact that the consulting engineer has the endorsement of the professional engineering societies. The consultant fee is paid without a murmur, and it often represents for a few hours what would pay the operating man for a month. Now, the consultant is absolutely justified in the fee he charges because he is capitalizing his years of experience and education. Stationary engineering or power plant engineering, from the operating point of view, is becoming a more highly specialized business. It is strictly in the hands of the operating or plant engineers themselves to achieve eventually a status equal to that of the professional man in other branches of engineering. It will not be done in a short time, but it can be done. Will it?

AN INVENTION EXHIBITION

One of the features of the Universal Exposition of Inventions and Patents to be held in Grand Central Palace, New York City, February 17-22, 1923, will be to celebrate, each day of the Exposition, one of the world's great inventors or scientists.

In view of the great interest shown by foreign governments in the Exposition, the first day, Saturday, February 17th, will be "International Day." Then, the following week will open with Sunday as "Marconi Day" or "Radio Day;" Monday, "Steinmetz Day," in honor of Dr. Chas. P. Steinmetz, the electrical wizard, of the General Electric Co.; Tuesday, "Edison Day," in honor of Thomas A. Edison, America's great inventor; Wednesday, "Bell Day," in honor of the late Alexander Graham Bell, who made the modern telephone possible; and Thursday, "Westinghouse Day," in honor of the late George Westinghouse, inventor of the air brake and many other inventions that have made railroad travel safe; and founder of the Westinghouse Electric & Mfg. Co., also the Westinghouse Air Brake Co., Pittsburgh.

The object of this Exposition is to fulfill an important universal need, and it is intended to:

(a) Bring the capital of America and the inventive brain of the world together.

(b) Give all inventors full opportunity to show the public, the manufacturer, the merchant, the capitalist and financier, the possibilities for utility, business, trade and commerce that lie in their inventions.

Inventors whose devices may be adjudged to combine novelty and utility with commercial practicability, will be awarded, by qualified board, cash prizes, gold, silver and bronze medals and certificates of merit.

The Exposition will be a veritable "Clearing House of Ideas" through which the man of originality and ideas is brought in personal contact with the man in need of ideas and with the man of money.

The Exposition of Inventions and Patents will be a place where anyone with an idea; formula; process; labor-saving plan, device, etc.; improvement on machinery; new invention; a developed and patented specialty, or anything saleable can exhibit. This will enable the manufacturer who is looking for some sort of device which will lessen the labor and cost of producing his wares, or assist in the economic production of his raw material or its procural, or help to secure the economic manufacture of such raw material; or the capitalist who is searching for some clever device or process in which he can see the possibility of increasing some of his idle money, go and see what the man of ideas has to offer.

NEW BOOK

A most interesting book has been published by the Taylor Stoker Co., illustrating a number of the large central station power plants in which the Taylor stoker has been installed. There are fifty of these installations in the book, which is of large size, 11 x 13, and printed on excellent paper. The chief object of the book is to show the class of power plants into which the stokers have been introduced, and on two pages facing each other are illustrations of the oldest and newest stations containing these installations. The plant of Bay Sate Street Railway Co., at Quincy, Mass., was equipped with Taylor stokers in 1905, and these are still operating. The illustration on the opposite page shows the new Hell Gate Station of the United Electric Power Co., which represents the very latest in power station design. The Taylor Stoker Co. has offices in Montreal and Toronto.

Self-Contained Coal Dryer, Pulveriser and Blower

Cheap Grade of Coal Used to Advantage—Any Desired Rate of Delivery—Preliminary Drying Process Unnecessary—Complete Combustion—Small Proportion of Paraffin Used

CONSERVATION of fuels is perhaps a matter that will more vitally concern the next rather than the present generation, but it is one that ought to occupy a prominent place in our scientific and industrial research work to-day. Cheapness of production, however, is an important present-day problem and one to which we must bend our untiring energies if we are to maintain our prestige and position in the world's commerce. Not the least factor in the cost of production is the item of fuel costs. With individual plants consuming over a thousand tons of coal per week and others using hundreds of tons of oil, the cost of fuel must bulk very largely in the annual balance sheet.

Of the various fuels available, pulverised coal would seem to offer many advantages from the point of view of cheapness. In the United States pulverised coal as a fuel has received much consideration and it has been widely adopted in many large power house plants. At the River Rouge boiler plant of the Ford Motor Co. the four supposed largest boilers in the world are fired by pulverised coal and blast furnace gas. This method of firing was only adopted after an exhaustive survey of all possible types and it would seem to indicate that there are potentialities in powdered coal that will well repay the careful consideration of fuel users.

In the cement industry it has been standard practice for many (about 60) years for firing rotary kilns. Whatever may be the impression regarding this fuel for other applications, such as boiler houses and furnaces, there can be no two opinions on its superiority for cement work.

In the utilization of powdered coal as a fuel there have been in the past both advantages and disadvantages. Among the latter were the costliness of the pulverising plant, the inadvisability of storing the powdered product for use, and difficulty in dealing with the ash. If these can be eliminated or at any rate considerably depreciated, there would seem to be a wonderful future for powdered coal. The advantages it claims are cheapness of fuel, extraction of most of the heating value, low labor costs, and the fact that low grade coal can give good results.

In the past a powdered fuel plant has not only been costly to install but equally costly to maintain and run, entailing, as it does, a coal dryer, with its auxiliary furnace, a tube mill or other pulveriser, elevators, conveyors, separators, bins and bunkers for storage, fans, etc. With the new invention named the Atritor all the disadvantages mentioned above are said to be eliminated. This machine dries, granulates, pulverises to any degree of fineness and delivers the fuel into the combustion chamber all in one continuous process as and when wanted, at any desired rate of delivery without any auxiliary plant whatever other than a feeding arrangement for the coal.

The first Atritor was put into commission about 12 months ago. During the intervening period this machine and two others have been subjected to very rigorous tests in the course of much experimental work. The machine as designed is known as the No. 10 size and it is guaranteed to give, with an actual power consumption of 30 h. p. an output of 1,800 lbs. of coal per hour pulverised from ¾-in. lumps to a fineness such that 95 per cent. will pass through a 100 x 100 mesh screen. A larger machine is also in contemplation.

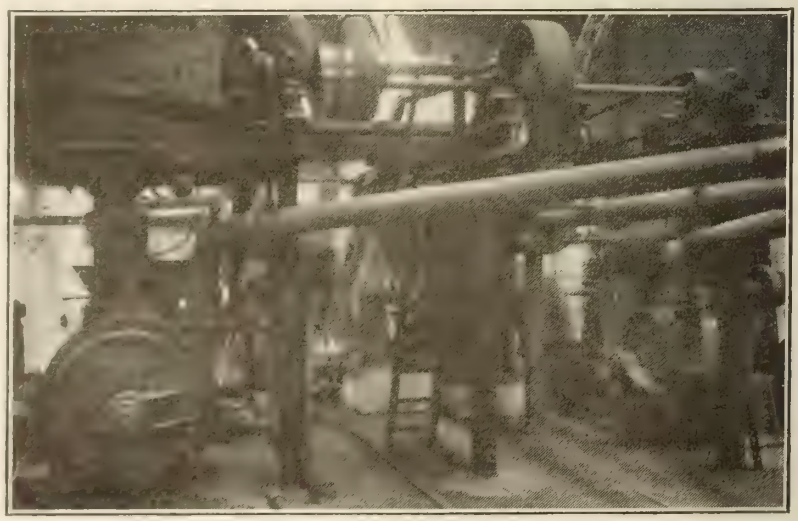
A typical Atritor installation as applied to two 140 ft. x 8 ft. rotary cement kilns is shown in the illustrations herewith and consists of two Atritors driven by 40 h. p. electric motors, each with a 10-ton raw coal hopper for feeding and an elevator for keeping the hoppers full, with a screw container from the elevator to one hopper. It is recommended that 40 h. p. motors be installed for driving this size of machine, though it will give full output when grinding coal not exceeding ¾ in. in any direction at 30 h. p.

An installation similar to that shown is capable of burning over 800 tons of cement per week. It is, however, advisable to have a third Atritor as a standby in case of breakdown through any cause. It is a simple matter to arrange the delivery pipes with flap valves so that any of the machines can deliver its product at the piont desired. The cost of pulverising coal by the Atritor system at Stockton is about 62c per ton, while by the old installation it was about $1.25 per ton.

Another decided advantage of the Atritor system of burning the fuel immediately is the fact that a lower grade of coal can be used with consequent decreases in cost. With the old type of plant a large part of the volatile combustible matter in the coal is lost during the drying operations and storage. The approximate difference between the lowest grade coal it was possible to utilize by the old system and the coal which can be burned quite satisfactorily by the Atritor system is about $2 per ton delivered at the works. The total costs for fuel burnt in the kiln, that is delivered at the works, handled and pulverised and propelled into the kiln are, therefore, $2.65 per ton by the old installation against $2.40 per ton by the Atritor.

The advantages of the Atritor system for pulverising coal may be summed up as follows:—

1. It is a small, self-contained unit for drying, pulverising and propelling the fuel direct into the combustion chamber ready for burning, in one continuous process.
2. It will deliver any quantity at any rate desired as and when wanted up to its capacity of 1,800 lb. per hour.
3. It is continuous in action and dis-



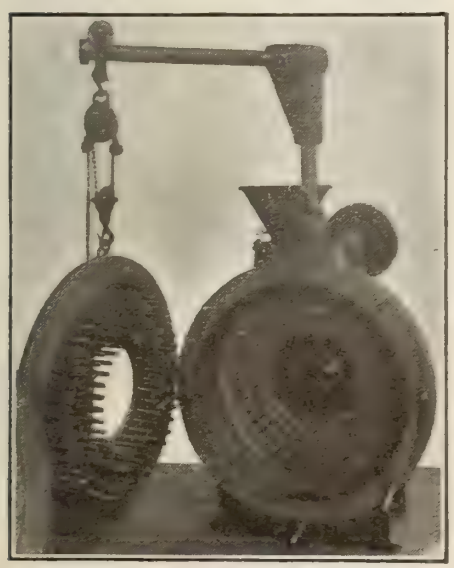
General installation of Atritor unit.

[illegible] Alfred Herbert, Ltd., who are the licensees and manufac-

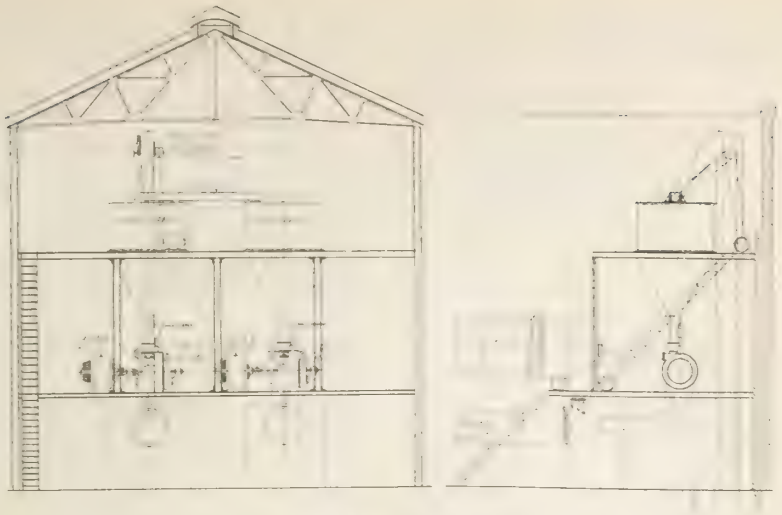
penses with the necessity for storage bins.

4. It can be started and stopped at will.
5. The drying and pulverising go on together and the product is burned immediately without opportunity to absorb moisture after pulverisation. This is important as powdered coal is extremely hygroscopic.
6. The whole of the combustible contents of the coal pass into the furnace and are burned. There is no opportunity for the volatiles to be lost. This is a very important point as considerable waste of volatiles takes place during drying and storage under the old system.
7. It entirely supersedes the elaborate, expensive and dusty plant hitherto employed for the purpose.
8. There is no necessity for any subsidiary plant other than a feeding device for the raw coal.
9. The cost of the installation is low. The power consumed is low. The cost of maintenance is extremely low.

   The labor cost is low.
10. It is entirely dustless in operation.
11. The moisture contents of the coal make no difference to the working of the machine or to the resultant product.
12. The hot air supply for drying can be drawn from any convenient source of waste heat.
13. No smoke or soot is formed and no combustible matter left in the ash.
14. Pulverisation may be carried to any degree of fineness desired.
15. A high temperature can be obtained very quickly.
16. By the addition of a minute amount of paraffin (a patented process) (.07 per cent. by weight of coal pulverised) the time for heating up is reduced by 75 per cent. A rotary kiln is ready for use 40 minutes after lighting up.
17. The addition of paraffin also enables coal which is unburnable when ground by other means to be successfully burned by this system.
18. There is no heat wasted nor waste of fuel when damping down.
19. There are no screens used and therefore no clogging of material.
20. An efficient metal separator is incorporated in the inlet end of the machine. This dispenses with the use of a magnetic separator.



Interior of Atritor showing arrangement of pulverizing pins.



Layout of Atritor installation.

The addition of paraffin during pulverisation has produced such almost extraordinary effects that the process has been patented. The requisite amount for firing up is .07 per cent. by weight of fuel burned or about 1½ pints per hour to 1,800 lbs. of coal. The paraffin can be shut off when full heat is attained, or it can be kept on when pulverising very inferior coal in order to assist in maintaining the temperature.

The mechanical features of the Atritor consist generally of: (a) A hopper with variable screw feed driven by cone pulleys and worm gearing and level operated slide, for regulating the flow of raw coal. (b) A coal chute and metal separator in which any material of heavier specific gravity than coal is thrown out and thus prevented from injuring the machine. (c) Hot and cold air supply ducts. (d) A casing with fixed pegs of extremely hard metal in concentric rings on both sides. (e) A rotor disc with similar pegs on each side and rejector pegs on one side. (f) A suction and blower fan cased in a scroll. In the scroll are auxiliary air ports.

The coal feeds through the slide and screw and falls towards the centre of the machine where it is met by a strong current of cold air which is being drawn through an adjustable opening in the front of the machine. The air draught is adjusted to the amount of coal feed so that all the coal is pulled into the machine but anything heavier than coal rejected, falling down to the air inlet, thus dispensing entirely with the necessity for a magnetic separator. The pull of the fan and centrifugal force throw the coal through the intermeshing rings of pegs in the first disintegrating chamber, called the first effect.

The coal particles are then drawn by suction towards the centre again through the chamber known as the second effect. It will be noticed that the rings of pegs go completely across the first effect, so that the coal has no loophole to escape their smashing action. In the second effect, the rotating rings of pegs only go across half the chamber, leaving half the volume free except for stationary pegs. The innermost ring on rotor is composed. however, of pegs which go completely across the chamber and enter a recess in the casing on the other side. This ring acts as a rejector for coal particles that may be still too large for use. In addition a set of eddy currents are set up towards the centre on the side of the casing and towards the periphery up the side of the rotor disc. The circulation thus set up in the second effect completes the pulverisation until the particles of coal are so impalpable that they are drawn by the fan and propelled into the furnace.

For full capacity of 1,800 lbs. per hour with only 5 per cent. residue on 100 x 100 screen the slide under the hopper should be full open and the screw feed on the fastest rate. Hot air should be drawn in at a temperature of round about 450 deg. to 600 deg. C. At this temperature coal of a high moisture content will be completely dried in its passage through the machine. The auxiliary air ports in the casing on the delivery side should be shut. If for any purpose the required output is to be less than the above. the slide should be closed first and the cold air inlet regulated so that no coal is rejected by the metal separator. For a still smaller output the screw should feed at a slower rate and the slide worked in conjunction. The cold air will have to be adjusted until coal is not thrown out by the separator. This may necessitate the opening of the auxiliary air ports to give sufficient air for combustion.

A safe rule when using a hack saw is to maintain an even pressure and to keep blade cutting.

Some Elements of Economy in Air Compression

Steam Driven Air Compressors of Single and Compound Types —Electrically Driven Machines—Methods of Lubrication and Governing—Cooling by Water Jacket and Intercoolers—Types of Valves, etc.

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SECOND only to electricity in the extent and diversity of application, compressed air is one of the most important agents in every phase of the development of civilization. In the arts, sciences and manufactures, its use has wrought economies which could otherwise never have been realized. Compressed air appliances have exercised an influence upon improved standards of living, second to no other means of power transmission and application. Wherever properly applied, they have brought about economic results which are reflected in every field of activity. But the efficient application of compressed air presupposes an efficient source of compressed air. The most economical devices cannot work to advantage under a high cost of power.

The cost of compressed air, for whatever purpose or however produced, involves three separate items;—first, interest and depreciation on the investment for compressing equipment; second, cost of operation; third, cost of maintenance or up-keep. Extravagance in any one, will offset saving in the other two. Compressed air can be had at minimum cost only when each of these three items is minimized. All three depend fundamentally upon the design and construction of the air compressor.

An air compressor is a machine for transforming energy from one form to another, and is to be considered as primarily made up of three parts, namely, the driving element, the compressing element, and the mechanical structure, combining these two which may be designated as the power transmitting element. It is not always possible to draw the line sharply between these several elements, but the subdivision can be made with more or less exactness.

In the transformation of energy there is a certain loss. The measure of overall efficiency of an air compressor is the ratio of the horsepower applied as initial energy to the horse-power represented delivered. The inevitable losses in air compression may be broadly classed under five headings, as follows:

The first loss is that due to friction in the mechanical structure which transmits the power from the driving to the compressing element. The second loss is that arising from the heating of the air during admission to the cylinder, resulting in a reduction of its density and a diminished volumetric efficiency of the cylinder. The third loss arises from the heating produced by compression and its effect upon the air during compression, calling for more power. The fourth loss comes from the reduced volumetric efficiency of the cylinder due to the fact that the intake air is seldom at atmospheric pressure owing to friction in the inlet valves and passages. The fifth loss is also one of volumetric efficiency due to the effect of the clearance air in reducing the effective length of the admission stroke.

These various losses can be kept down to the minimum by correct design, and construction, but they can never be entirely eliminated. It is not possible even to give average percentages for any one of these losses, which may occur in different combinations, depending upon the mechanical details, the general type, the speed and the capacity of the compressor. After all these losses have been deducted the net efficiency of the machine remains, and of this Mr. Frank Richards says, "It is safe to say that the ultimate efficiency never goes as high as 80 per cent., while it often goes below 60 per cent."

Taking up now, in order, the three primary parts into which the compressor has been divided, the driving element comes first for consideration. Air compressors can be broadly defined as either steam driven or power driven.

The Steam Driven Machine

The ordinary steam driven compressor is simply a steam engine with one or more air cylinders directly coupled on an extended piston rod. With this understanding it will be unnecessary here to enter into any detailed consideration of the design of the steam end. What constitutes good steam engine practice is the best compressor practice so far as the steam end of the compressor is concerned.

However, there is one vital distinction between engine and compressor practice. The steam engine for ordinary power purposes must maintain a constant speed irrespective of load. The steam driven air compressor, on the contrary, in order to maintain its output of air properly adjusted to its load, must run at a variable speed, for its piston displacement or its capacity is directly proportional to its speed. This means that while the steam engine has a variable load per stroke, the air compressor has a constant load per stroke, except for the small discrepancy due to varying friction and compression efficiency at varying speeds.

This feature has no particular bearing upon the performance of air compressors with simple steam cylinders, but it has a most important bearing upon the application of compounded steam cylinders to compression work. The first essential of successful steam compounding is in maintaining the proper ratio of expansion. This means that for a given steam pressure, for a given back pressure and for a given cylinder ratio, there is one and only one proper point of cut-off for both steam cylinders.

In any given case the first and third conditions must be considered constant, leaving the second condition as the variable which is to be adjusted to meet varying conditions. Where a constant speed must be maintained regardless of load, this must be accomplished by change of cut-off; and in compounded steam cylinders this immediately destroys the proper ratios of compression, and sacrifices economy. Constant speed practice with compounded engines must be a compromise, even at the best.

But in the air compressor, where the load per stroke is constant, the cut-off on the steam cylinders remains practically constant, and the correct ratio of expansion is maintained over the full load range. The word "practically" is here used advisedly, since there is bound to be a very slight departure from perfect conditions to produce the necessary change of speed under varying loads. But it will be evident that the air compressor offers the ideal opportunity for securing in highest degree the advantages of steam compounding.

It would appear proper that in steam driven air compressors the first element of economy lies in using compounded steam cylinders, operating under pressure which will make the saving worth while. The peculiar operating conditions of the air compressor, just explained, justify compounded steam ends under pressures lower than would be advisable in ordinary engine practice. The largest builders of air compressors are recommending steam ends for as low as 80 pounds boiler pressure running condensing, and for 100 lbs. running non-condensing.

The three fundamental advantages of compounded steam cylinders on air compressors may be summarized as follows: Lower fuel consumption and fuel cost, lower cost of boiler feed water, lower cost of boiler plant and accessories.

In Canada, due to extensive Hydro electric developments, and electric pow-

er frequently becoming available after steam driven compressors are installed, a large Canadian builder has adopted the standard of building all of their steam driven compressors with the air compressing cylinders located next to the frame so that the machine is readily convertible to a belt driven machine when power other than steam is available.

Turning now to the subject of power driven compressors, they are in general an evolution from steam driven types. They differ, however, from the others in the vital fact that while steam driven compressors are variable speed machines, power-driven compressors are in the vast majority of cases constant speed machines. This makes the problem of regulation quite distinct in the two cases. This point will be taken up more fully later on.

Belt and Other Drives

Discussing now the various methods of drive, belt drive is the most common and is always applicable either from line shaft on smaller sizes or by individual driving element using either electric motor or oil engine belted to suitable belt wheel. A good rule to follow for belt centres is the diameter of the driven pulley plus 8 to 10 ft. Where long belt centres cannot be had the short belt drive referred to later can be applied.

Rope drive is perhaps the next choice, although it is seldom used where the power to be transmitted is small. It is particularly advantageous in large sizes where short centres only can be had, as the grip of the rope in the grooves gives the necessary pulling power without undue tension and bearing friction. The durability and efficiency of the rope drive depend entirely upon the shape of the rope grooves and upon the use of a suitable number of ropes so that no one rope is under excessive strain.

The use of tighteners for rope is always to be avoided. A recent development by one of the larger builders, however, opens up large possibilities for belt drive on close centres without any increased friction. This arrangement involves the use of a floating idler pulley and a very slack belt. The weight of the idler takes up the slack of the belt and increases the arc of contact on the driving and driven pulleys so that the full power is transmitted without any undue strain on the bearings or on the belt itself.

Gear drive and silent chain drive are never desirable and should be used only where the demand for compactness renders them imperative. The best practice places the limit of power for gear drive with a raw hide pinion at 40 h. p.; for gear drive with a steel pinion at 60 h. p.; and for silent chain or herringbone gear drive at 50 h. p.

A very modern development is the direct-connected electric driven air compressor with the rotor of a synchronous motor mounted directly on the compressor shaft. This construction is not applicable to smaller units than about 700 cu. ft., 100 lbs. pressure compressors, because the cost for D. C. synchronous motors of small power becomes excessive. On moderate and large-sized machines, however, this design affords the very highest possible economy in power driven compressors. Recent improvements in air valve movements and in air cylinders design which permit much higher piston speeds than ever before were considered practical, have contributed to the success of the direct-connected compressor unit of this design. Unless the valve and port areas are very large, the compression efficiency is so greatly reduced at the customary speeds as to offset the advantages of compactness. The choice of a direct-connected motor driven air compressor therefore, should be determined by an investigation as to whether the compressor had been specially designed for this method of drive.

The same general remarks apply to the direct-connected water wheel compressor. But as this style of drive is comparatively rare and can be used only where the head and volume of water are exactly right, this condition is not likely to come within the experience of the engineer.

The extensive use of compressed air for operating tools and other equipment by compressed air has created a demand for a new design of air compressors, that is, the portable type of machine, and the development of a complete line of these machines has been undertaken by a large builder. They can be gasoline engine driven, self propelled, for operating on standard gauge railway track or gasoline engine driven or motor driven portable units. In ranges of capacity these machines are available in 100, 150 and 200 cubic feet units.

The problems encountered in a steam cylinder of an air compressor are problems of expansion. Coming now to a discussion of the second element in the air compressor—the compressing element—we find here that the problems are those of compression, almost an exact reverse of those in the steam end. In compressing air all of the energy applied is converted into heat. At first glance, therefore, economical considerations would seems to indicate that this heat should be retained during compression. As a matter of fact, however, economical air compression depends primarily upon the thoroughness with which the heat of compression is removed as fast as it is produced. Compressor practice uses one or both of two methods for accomplishing this, namely, water-jacketing, and compounding or stage compression.

If the piston of a compressing cylinder could move so slowly that the water in the jacket could absorb and carry off all the heat, it is evident that this jacketing process would save all the work which is represented on the indicator diagram by the areas between the actual compression line and the isothermal curve. But in actual practice a compressor cannot be run so slowly, and water jacketing is only a partial solution of the cooling problem.

Temperatures increase with the pressure in the cylinder, and it is evident that the advancing piston steadily reduces the effective area of jacket. Near the end of the stroke, when pressure and temperature are highest, very little of the cylinder wall is exposed, and the greater part of the cooling area remaining in the cylinder head. This emphasizes the importance of head jacketing and the superiority of those constructions in which the air valves are not in the heads, thus affording the largest percentage of cool head areas.

But even under the best conditions, water jacketing realizes only a part of the saving which its theory promises. Some beneficial effect in this respect it certainly has, particularly in slow speed, long-stroke machines. But probably its greatest value lies in its effect upon the lubrication and the resultant wearing qualities of the machine. Compression at sea level and ordinary atmospheric temperature to only 75 lbs. gauge produces a temperature of about 400 degrees Fahr. If some means were not employed to reduce this temperature, the inevitable result would be the destruction of all ordinary lubricants and packings, and the rapid wear of piston rings, cylinders, rods and valves with extravagant leakage, loss of capacity, increased friction and excessive power consumption. But the water jacket keeps all parts reasonably cool and results in tight joints, free lubrication, little wear, reduced friction, easy running, and sustained capacity and efficiency.

Lubrication

It would seem advisable at this point to make some mention of the lubrication of air compressors as it has been found that not sufficient attention is given to this subject and the author will only touch on the subject briefly, and dealing only with the lubrication of the air cylinders of the air compressing element. For average normal conditions, the oil should be a medium bodied mineral of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture.

The quantity of lubricating oil to feed to the air cylinders of compressors cannot be stated in exact terms due to the varying viscosity of different oils, the heat of compression and the size of cylinder. It may be stated in general, however, that after the cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of accumulation of carbon and sooty deposits within the system due to excessive use.

Cooling

It is perhaps unnecessary to say that it is almost as important that air should be admitted into the cylinder cool, as that it should be kept cool during com-

pressure. If a water jacket were not used, the entering air would be heated while passing through the hot valves and ports and by contact with the heated interior of the cylinder. This would mean the rarification of the intake air, reduced cylinder capacity, lower effeciency of [illegible] and excessive terminal temperature. Since jacketing is at the best [illegible] ally effective, this latter argument suggests the advantage of those constructions which admit air through one, or at least only a few, large openings where only the outer film of the air is heated rather than through a number of smaller openings through which the air is finely sub-divided and heated.

The second process of cooling—compression in stages—is analagous to an arrangement in which the compressing piston of a single cylinder is stopped at intervals through its stroke and the partially compressed and heated air is withdrawn and cooled by some external means to its initial temperature or even lower; then returned to the cylinder to be further compressed, heated and cooled, until the desired pressure is reached. It is evident that such an arrangement would maintain a fairly uniform low temperature in the air volume throughout the stroke, giving very close to isothermal compression.

Such a proceeding is evidently not practical. But the same results may be obtained by compressing in several cylinders, in the first of which moderate pressure and temperature is reached and the air in this condition discharged through a cooling device which restores its initial temperature; then admitted to another cylinder for further compression and heating; again withdrawn and cooled and again compressed. This is a stage of compound compression. An average of the practice of the leading builders permits single stage compression for pressures up to 70 pounds or under some conditions to 100 pounds; two-stage compression for pressures of 75 to 500 lbs.; three or four-stage (preferably in duplex compressors) for pressures of 500 to 1,500 lbs., and four-stage compression for pressures from 1,500 lbs. up.

A three-stage straight line machine should only be used for small or moderate capacities. Above this, the duplex [illegible] would be preferred because of its balanced construction and of the readiness with which it is compounded.

The primary object of compound compression is a saving of the power required by what may be called the heat element in compression. The degree to which this is accomplished depends entirely upon the efficiency of the intercooler. The ideal intercooler would be one which would reduce the temperature of the cooling water. This probably cannot be realized, but a good practical standard demands that the intercooler shall deliver air at a temperature not more than 10 degrees above that of the cooling water.

The successful intercooler involves six fundamental requirements. It must provide for a complete and minute sub-division of the air passing through it, that the heat may be dissipated without any dependence upon the best conducting qualities of the air itself. The air should be split up into thin sheets or streams so as to dissipate its internal heat. There must be an ample cooling surface presented to this subdivided air stream. The circulation of the cooling water must be properly directed in relation to the flow of the air, and its velocity must be such that the maximum amount of heat will be carried away without waste of water. All air passages must have ample cross section, that the velocity of air may be such as to give a length of contact with the cooling surfaces sufficient for the complete removal of the heat. Expansion and contraction must be provided for that there will not be a leakage of air or of water.

Compound air compression has important bearings upon other features of compression economy. It reduces the average structural stresses, resulting in a higher factor of safety and a longer life for the machine with a given weight of metal. The maximum stresses encountered in compression in two stages are only 55 or 60 per cent. of what they are in single stage compression to the same pressure. The reduction of stresses here referred to is felt not only in the machine structure but in the air valves, which show a notably easy operation under compound conditions. Another advantage of compound compression is an improved steam economy if the compressor is steam driven. The averaging of the stresses throughout the stroke, permits the work to be done, with a lower M. E. P. in the steam cylinder, which means a shorter cut-off and a greater steam economy. The reduced terminal stresses permit a higher piston speed with safety, thus improving the steam economy by reducing condensation losses and leakage in the steam cylinder.

High volumetric efficiency results from compound compression, coming from three sources. The first of these is the fact that the clearance pressure in the intake cylinder is lower. The second is a lower maximum temperature in the cylinders so that the entering air is not so much heated. The third is a reduction of leakage consequent upon the reduced extremes of pressure in each cylinder. Compound compression results in more efficient lubrication of the machine because of the lower temperatures involved. This means easier running, improved mechanical efficiency, less wear, lower repair costs, reduced leakage losses, and longer life. Compression in stages results in the delivery of drier air, a feature of great importance where the air is used under conditions which may result in freezing up of the exhaust ports. This also largely obviates the accumulation of water in pipe lines.

Air Valves

The air valves of a compressor are probably the most vital parts of a machine. While the number of different types of air valves is greater than the number of compressor builders, yet they may be broadly classified in two groups. Mechanically actuated valves have a positive motion derived through some mechanical connection from the rotating or reciprocating parts of the compressor. Poppet or automatic valves are operated wholly by differences of pressure. There are other designs of air valves in use today which cannot be exactly placed in either class but these need not be considered at this time as they generally are applied for special purposes and in special cases.

Without going into a detailed discussion of the many different types of air inlet valves, some general observations may be made as to their function and requirements. The function of an inlet valve is to admit the maximum volume of cool, clean air to the cylinder, with the least expenditure of power; to keep this air in; and to continue to perform this duty indefinitely at the least total cost. Analysis of this function reveals the following requirements of the successful inlet valve.

It must admit a volume of air which will entirely fill the cylinder, this air being as nearly as possible at atmospheric pressure. This calls for an instantaneous and complete opening of the valve, so timed that there shall be no escape of the compressed air in the clearance space. This full opening should be held to the end of the stroke, and short, direct and unobstructed passages should be provided through ports and valves.

It must admit clean air, suggesting a design permitting ready connection to an intake passage or conduit leading to a place free from dust and grit. The air admitted must be as cool as possible —a condition partially met by the consideration just mentioned by which cool air as well as clean air should be supplied. But, more than this, the cool air supplied should nowhere be heated in its course into the cylinder, suggesting that valves, ports and passages shall be so placed as to be cooled by the cylinder jacket.

All the air admitted must be kept in the cylinder, calling for instantaneous and complete closing of the valve at the end of the stroke, with a perfect seating and without any leakage. All the processes outlined here must be carried on with the least possible expenditure of power for the overcoming of friction and the manipulation of the valve gear—a requisite demanding nice adjustment, simplicity of mechanism, perfect lubrication and as few wearing surfaces as possible. This exacting performance must be continued indefinitely, twice each revolution and hundreds of times per minute without undue wear or loss of adjustment. This condition is fundamentally one of correct design, high class materials and workmanship and generous lubrication.

(To be continued)

Second Revision of A. S. M. E. Boiler Code

A HEARING is held by the Boiler Code Committee at least once in four years, at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances. The year 1922 becomes the period of the second revision, the first revised edition of the Boiler Code having been issued in 1918. The Boiler Code Committee plans to hold a Public Hearing in connection with the next Annual Meeting of the American Society of Mechanical Engineers, in December, 1922, to which the membership of the Society and everyone interested in the steam-boiler industry will be invited and where they may present their views.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Power Boiler Section of the Code, as a result of the interpretations issued and also of the formulation of the Locomotive Boiler and the Miniature Boiler Codes. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote an extra day at each of its monthly meetings to the consideration of the proposed revision. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

In connection with the revision work, the lack of rules and specifications relative to pipe, pipe material and fittings for use in connection with steam boilers up to the flanges for the connection of the first valves, has been apparent. The Committee has endeavored, at the urgent request of many manufacturers, to supply this lack by rules and specifications which have been prepared in co-operation with the American Society for Testing Materials. These rules and specifications are here published and it is the request that they be fully and freely discussed so that it may be possible for anyone to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th Street, New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

Rules for Pipe, Pipe Material and Fittings Used on Steam Boilers

X-1. Piping and Fittings.—The piping and fittings used on boilers up to the flanges for the connection of the first valves from the boiler on steam outlets, feed lines and blow-off lines shall conform to the rules given in X-1 to X-6, and it is desirable that all piping, valves and fittings used on steam and exhaust lines including the vacuum system and drain lines; all water lines, including boiler-feed suction and discharge lines; and all boiler blow-off lines shall conform to them.

X-2. Steam Pipe.—Piping for steam mains carrying saturated or superheated steam may be of welded or seamless pipe made of wrought iron or steel. For sizes above 3 in. in diameter the steel pipe shall be of open-hearth steel. All pipes shall be straight and free from blisters, cracks, laminations and other injurious defects. Liquor marks and lap-seam lines incidental to the manufacture of pipe is to be inspected separately for defects on the inside and outside, noting particularly the character of the cross-section when cutting off crop ends. Pipe up to 3 in. in diameter may be butt-welded or lap-welded while that above 3 in. in diameter shall be lap-welded. Pipe material shall correspond with that required by the specifications of wrought-iron and steel pipe included in Par. X-9, et seq.

X-3. Thickness of Steam Pipe.—In determining the thickness to be used for pipes at different pressures and for temperatures not exceeding 700 deg. Fahr., the following formula is to be used:

$$P = \frac{2\,S\,(t - 1/16)}{D}$$

where:

P = the working pressure in lb. per sq. in. above atmosphere
t = thickness of walls in inches
D = inside diameter of pipe in inches
S = 3500 lb per sq. in. for seamless steel pipe
= 3200 lb. per sq. in. for lap-welded steel pipe
= 2500 lb. per sq. in. for butt-welded steel pipe
= 2500 lb. per sq. in. for lap-welded iron pipe
= 2000 lb. per sq. in: for butt-welded iron pipe
= 2000 lb. per sq. in. for brass pipe
= 2000 lb. per sq. in. for copper pipe.

X-4. Feed Lines.—High-pressure hot-water and cold-water lines may be made of welded or seamless pipe of wrought-iron or steel as called for under X-2. Where the water contains corrosive material or air, brass or copper tubing may be used. In determining the thickness of water pipe the following formula will be used:

$$P = \frac{2\,S\,(t - 3/32)}{D}$$

where: P = water pressure in lb. per sq. in.
t = thickness of pipe in inches
D = inside diameter of pipe in inches
S = 2625 lb. per sq. in. for seamless steel pipe
= 2400 lb. per sq. in. for lap-welded steel pipe
= 1875 lb. per sq. in. for butt-welded steel pipe
= 1875 lb. per sq. in. for lap-welded iron pipe
= 1500 lb. per sq. in. for butt-welded iron pipe
= 1500 lb. per sq. in. for brass pipe
= 1500 lb. per sq. in. for copper pipe.

Where brass pipe is desired for finish or for any other reason it may be used. The brass and copper pipes used shall correspond to the specifications given under Pars. ..... and the brass pipe shall be half-annealed in order to leave it in proper condition for use in feed-water piping.

X-5. Blow-off Piping.—Blow-off pipe is to be of extra strong size and to be made of genuine wrought iron or steel as preferred.

X-6. Pipe Bends.—Pipes when bent may be made of steel or wrought iron and after bending are to be free from buckles and blisters and practically circular in cross-section. They are to be bent before being threaded or flanged, and where flanged they are to be refaced to dimensions so that they may be bolted or faced without forcing. Where possible, the tangent length of pipe at the end of each bend should be of a length equal to at least twice the nominal diameter of the pipe, although tangents may be used with lengths which are equal to the nominal diameter of the pipe. The advisable radius to which pipe should be bent should be five or six times the nominal diameter of the pipe, although pipe may be bent to a radius equal to four times the diameter of standard pipe and three and one-half times the diameter for extra strong pipe up to 12 in. The thickness of the pipe is to be determined by the formula given in X-3. The boiler-feed line bends are to conform with the above, while for blow-off lines the rules are to be applied to extra strong pipe.

Specifications for Welded and Seamless Steel Pipe

X-7. These specifications cover "standard" and "extra strong" welded and seamless steel pipe, but not "double extra strong" pipe. Pipe ordered under these specifications are intended for bending, flanging and other special purposes.

I—Manufacture

X-8. (a) The steel for welded pipe shall be of soft weldable quality made by the Bessemer or open-hearth process. The steel for seamless pipe shall be made by the open-hearth process.

(b) Welded pipe 3 in. or under in nominal diameter may be butt-welded, unless otherwise specified. Welded pipe over 3 in. in nominal diameter shall be lap-welded.

II—Chemical Properties and Tests

X-9. Open-hearth steel shall conform to the following requirement as to chemical composition:

Phosphorus, not over 0.05 per cent.

III—Physical Properties and Tests

X-10. (a) The material shall conform to the following minimum requirements as to tensile properties:

	Welded Bessemer	Welded Open-Hearth	Seamless Open-Hearth
Tensile strength, lb. per sq. in.	50000	45000	48000
Yield point, lb. per sq. in.	30000	25000	26500
Elongation in 8 in., per cent.	18	20	18

(b) The yield point shall be determined by the drop of the beam of the testing machine.

X-11. (a) Welded pipe shall be tested at the mill to the hydrostatic pressures specified in Table 1.

TABLE I. HYDROSTATIC PRESSURES FOR WELDED STEEL PIPE

Black and galvanized. Pressures expressed in pounds per square inch).

				"Standard" Pipe		"Extra Strong" Pipe	
Nominal Inside Diameter, In.	Actual Inside Diameter, In.	Actual Outside Diameter, In.	Weight of Pipe per Foot, Plain Ends, Lb.	Butt-weld	Lap-weld	Butt-weld	Lap-weld
⅛	.269	.405	.244	700	. . .	700	. . .
¼	.364	.540	.424	700	. . .	700	. . .
⅜	.493	.675	.567	700	. . .	700	. . .
½	.622	.840	.850	700	. . .	700	. . .
¾	.824	1.050	1.130	700	. . .	700	. . .
1	1.049	1.315	1.678	700	. . .	700	. . .
1¼	1.380	1.660	2.272	700	1000	1500	2500
1½	1.610	1.900	2.717	700	1000	1500	2500
2	2.067	2.375	3.652	700	1000	1500	2500
2½	2.469	2.875	5.793	800	1000	1500	2000
3	3.068	3.500	7.575	800	1000	1500	2000
3½	3.548	4.000	9.109	. . .	1000	. . .	2000
4	4.026	4.500	10.665	. . .	1000	. . .	2000
4½	4.506	5.000	12.340	. . .	1000	. . .	1800
5	5.047	5.563	14.324	. . .	1000	. . .	1800
6	6.065	6.625	18.762	. . .	1000	. . .	1800
7	7.023	7.625	23.544	. . .	1000	. . .	1500
8	7.981	8.625	28.554	. . .	800	. . .	. . .
8	7.813	8.625	28.61	. . .	1000	43.39	1500
9	8.937	9.688	34.19	. . .	900	48.73	1200
10	10.019	10.750	32.00	. . .	600	. . .	. . .
10	9.750	10.750	35.00	. . .	700	. . .	. . .
10	9.562	10.750	41.13	. . .	900	54.47	1600
10	9.312	10.750	46.25	. . .	800	60.08	1000
12	11.000	12.750	45.00	. . .	600	. . .	. . .
12	10.750	12.750	50.71	. . .	800	65.42	1600

For pipes over 12 in. in inside diameter, the test pressures should be calculated by the formula P=2St D, in which P= pressure in pounds per square inch; S=fiber stress=12,000 lb. per sq. in.; t=thickness of wall in inches; D=diameter in inches.

(b) Seamless pipe shall be tested at the mill to hydrostatic pressures not exceeding that required by the formula:

$$P = \frac{2\,S\,t}{D}$$

in which P=pressure in pounds per square inch; S=allowable fibre stress =16,000 lb. per sq. in.; t=thickness of wall in inches; and D=inside diameter in inches.

X-12. (a) For lap-welded pipe over 2 in. in diameter, a section of pipe 6 in. long shall be flattened between parallel plates until the distance between the plates is one-third the outside diameter of the pipe with the weld located 45 deg. from the line of direction of the applied force, without developing cracks.

(b) For butt-welded pipe over 2 in. in diameter, a section of pipe 6 in. long shall be flattened between parallel plates until the distance between the plates is 60 per cent. of the outside diameter of the pipe with the weld located 45 deg. from the line of direction of the applied force, without developing cracks.

X-13. For pipe 2 in. or under in diameter, a sufficient length of pipe shall withstand being bent cold through 90 deg., around a cylindrical mandrel the diameter of which is 12 times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld.

X-14. (a) Test specimens shall consist of sections cut from a pipe. They shall be smooth on the ends and free from burrs.

(b) Tension test specimens shall be longitudinal.

(c) All specimens shall be tested cold.

X-15. One of each of the tests specified in Pars. X-10, X-12 and X-13 may be made on a length in each lot of 500 or less, of each size. Each length shall be subjected to the hydrostatic test.

X-16. If the results of the physical tests of any lot do not conform to the requirements specified in Pars. X-10, X-12 and X-13, retests of two additional pipes shall be made, each of which shall conform to the requirements specified.

IV—Workmanship and Finish

X-17. For pipe 1½ in. or under in inside diameter, the outside diameter at any point shall not vary more than 1/64 in. over nor more than 1/32 in. under the standard size. For pipe 2 in. or over in inside diameter, the outside diameter shall not vary more than 1 per cent. over or under the standard size.

X-18. Unless otherwise specified, pipe shall conform to the following regular practice:

(a) Each end of standard welded pipe shall be threaded.

(b) Extra strong welded pipe and standard and extra strong seamless pipe shall be furnished with plain ends.

(c) All threads shall be in accordance with the American Standard and cut so as to make a tight joint when the pipe is tested at the mill to the specified internal hydrostatic pressure. The variation from the standard, when tested with the standard working gage, shall not exceed a maximum of one and one-half turns either way.

(d) Each length of threaded pipe shall be provided with one coupling, having clean-cut threads of such a pitch diameter as to make a tight joint. Couplings may be made of wrought iron or steel.

X-19. The finished pipe shall be reasonably straight and free from injurious defects. All burrs at the ends of the pipe shall be removed.

V—Inspection and Rejection

X-20. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector, free of charge, all reasonable facilities to satisfy him that the pipe are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the work.

Each length of pipe which develops injurious defects in shop working or application will be rejected, and the manufacturer shall be notified.

Specifications for Welded and Seamless Wrought-Iron Pipe

X-21. These specifications cover "standard" and "extra strong" welded wrought-iron pipe, but not "double extra strong" pipe.

X-22. All pipes to be used on locomotives and cars shall be of coiling or bending quality.

I—Manufacture

X-23. (a) The iron shall be made from muck bars, made from puddled pig iron, free from any admixture of iron scrap or steel.

(b) All pipe 3 in. or under in nominal diameter may be butt-welded, unless otherwise specified. All pipe over 3 in. nominal diameter shall be lap-welded.

X-24. Iron Scrap. This term applies only to foreign or bought scrap and does not include local mill products, free from foreign or bought scrap.

II—Physical Properties and Test

X-25. (a) The material shall conform to the following minimum requirements as to tensile propertites:

Tensile strength, lb. per sq. in.	40,000
Yield point, lb. per sq. in.	24,000
Elongation, in 8 in., per cent.	12

(b) The yield point shall be determined by the drop of the beam of the testing machine. The speed of the cross-head of the machine shall not exceed ¾ in. per minute.

X-26. All pipe shall be tested at the mill to the hydrostatic pressures specified in Table I.

X-27. A section of pipe 6 in. in length shall be flattened until broken by repeated light blows of a hammer or by pressure; the fracture developed shall have a fibrous appearance.

X-28. For pipe 2 in. or under in diameter, a sufficient length of cooling or bending pipe shall withstand being bent cold through 90 deg., around a cylindrical mandrel the diameter of which is 15 times the nominal diameter of the pipe, without developing cracks at any portion and without opening the weld.

X-29. (a) Test specimens shall consist of sections cut from a pipe. They shall be smooth on the ends and free from burrs.

(b) Tension-test specimens shall be longitudinal.

(c) All specimens shall be tested cold.

X-30. One of each of the tests speci-

(Continued on page 32)

Member of the Audit Bureau of Circulations

POWER HOUSE

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Oil Fuel Enthusiasm

WE NOTE in practically every daily paper we pick up, and in our passage through the streets, that there are a number of individuals or corporations offering the public oil burning apparatus for domestic purposes. This sudden rush into the field of oil fuel appliances is of course an effect of the feared shortage of coal, and was to be expected.

There is no reason why oil should not be capable of being burned successfully in a domestic furnace any more than in a steam boiler, but the question in both cases, is which is the most advantageous? With oil, of course, there is no removing of ashes, and no cleaning of grates, at least there should not be. So far that is a distinct advantage to the householder, and there are no doubt many such who would be prepared to pay for that convenience, in any case. As regards economy of operation, that depends on a large number of factors, such as the type of burner, the furnace arrangements, and the relative cost of oil and coal. It must not be imagined that oil is inevitably cheaper than coal to burn. It can be burnt just as wastefully, though the waste is perhaps not so apparent to the eye. From the point of view of cost, when the price of oil per pound is in the neighborhood of double the cost of coal, then the economical advantage vanishes.

Some of these burners are being offered to the public at a price which can only be characterized as excessive. Some of them have merit from an engineering point of view, others are perhaps best described as crude. We are of the opinion that a really adequate oil burner, that could be handled by the female portion of the family, and that was so constructed as to give the most efficient combustion results with low priced oil, would be a distinct benefit to the community. We do not mean that it would displace coal, but it would certainly act as a regulator on the price demanded for coal, while the coal would also act as a deterrent on undue inflation of the price of oil. We have seen a number of oil burners developed by earnest and enthusiastic gentlemen, and we have been shown beautiful colored flames, etc., but we have not yet seen such a thing as authentic figures on the performance of any of them.

We would advise the general public to examine very carefully, and if possible with the aid of someone thoroughly familiar with the subject, any oil burning apparatus they may feel inclined to purchase. It is hard to escape the impression that some of those offered have been developed purely with the idea of cleaning up while the present coal shortage is making people anxious to buy anything that promises relief.

A Personal Message

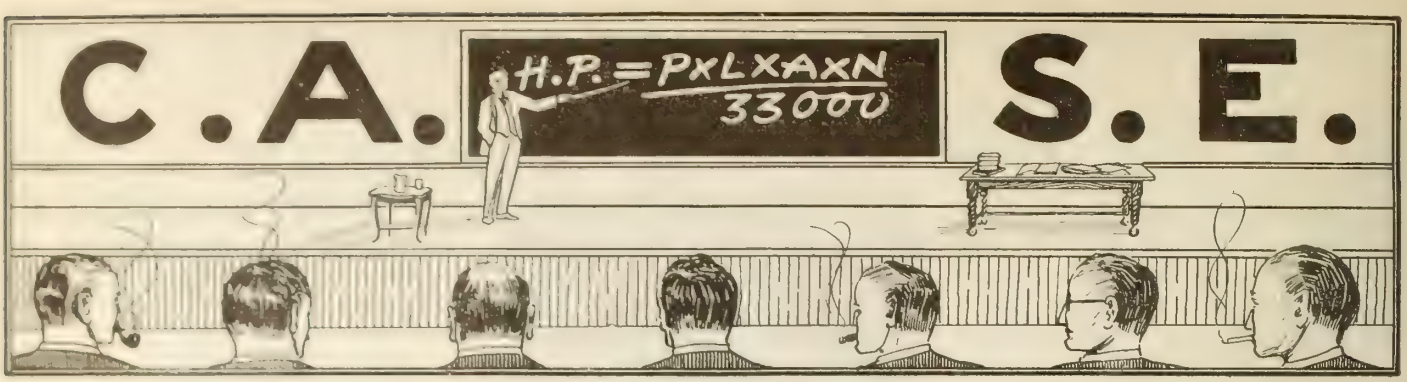
IN THE issue of May 5th, 1920, of this journal, the writer addressed a message under this heading to the readers of "Power House." That was on the occasion of his taking over the editorial chair, and now, on this occasion, the same medium is being used to wish the readers farewell. During the intervening time, it has been a privilege to gain a closer acquaintanceship with the subscribers and contributors of "Power House," and in some small measure to have assisted them from time to time with the problems of their daily work. It is with a feeling of regret that is unavoidable, that these pleasant relations are concluded. However it is a source of pleasure to the writer that the new sphere of activities to which he is called will allow him to gain perhaps a closer personal touch with at least some of his old friends, his future duties being that of Manager and Chief Engineer of the Boiler Insurance Department of the General Accident Assurance Co.

As has so often been said in these columns, the usefulness of a magazine of this kind depends to a large extent on the sympathetic support of the readers, and an earnest appeal is extended to them for their support in the future, as it has been so loyally given during the present editor's incumbency. The paper can be made largely a medium for the betterment of the status of the engineer in general, by the use of its columns freely in the discussion of their problems and difficulties, not only in a technical, but in a personal way.

The "Power House" as the only Canadian magazine published for Canadian engineers, dealing with conditions as they prevail in Canada, as well as the progress of all branches of power plant engineering as they develop in different parts of the world, is worthy of the support of all those whose lives are bound up with Canadian development along these lines.

It is the earnest wish of the writer that he may be privileged to see the power plant engineer in Canada make a steady progression, until he attains the standing in the industrial community to which his qualities and faithful application to duty entitle him, and in whatever small way he can help this development, his services will willingly be given. In education lies their chief hope, and all their endeavors should be directed towards the attainment of the highest possible standard along that line.

To the readers, contributors and advertisers of "Power House" the writer wishes "Good-bye and good luck."



Going Into the Burning Oil Question

After Hearing a Number of Arguments Pro and Con at a C.A.S.E. Meeting, "Johnny Shovel" Goes Out and Does Some Investigating for Himself

By "JOHNNY SHOVEL"

A FEW days after the C.A.S.E. meeting, we got thinking about the talk and the discussion on oil fuel, particularly about the argument as to when conditions make it cheaper to burn oil than coal.

The discussion brought up several points on which the wise ones could not give the data. For instance, not a soul in the hall knew whether we Canadians buy oil by the U.S. gallon or the British Imperial gallon. Naturally, it makes a big difference, for the gallon of oil U.S. measure weighs almost 2 lbs. less, and does nearly one H.P. less work than the Imperial gallon will do.

For figures we got some pretty arguments. It being one of the rules laid down by the Educational Committee that no text boks can be used in the hall on meeting nights. One man's memory is considered as good as another's, so the point cannot be settled by recognized authority. What we were told about the various fuels lost a good deal of its value, because, in most cases, neither the speakers themselves nor we who heard them, knew the exact wording of the law applied or the correct formula.

Working Without Tools

Getting a man to do one of those questions without a handbook is like sending a workman to take measurements without a rule, and if we were picked on to do one, we know we couldn't "think on our feet" and we certainly would ask the boss for the keys to the tool cupboard, meaning the library, for the Constitution of the C. A. S. E. provides for a library and question time is certainly the time to us it.

The Reference Library

The question was "How do you figure the total cost of the two fuels to find out which one is the cheapest to burn?"

The man who had been talking on oil told us there were a great many things to think of besides the actual cost of the fuels themselves. Any one considering oil should make sure that his plans for tanks, piping, etc., are accepted by the local authorities and his insurance company. Most important of all is to know what the nearest branch of the oil company will supply the oil for and how long the price will remain fixed. After that one can begin to consider things directly concerned with the production of power, such as the water each fuel will evaporate, the efficiency of the boilers, the cost of labor for firing and handling fuel and waste.

He said he knew of a chart in some handbook which compares oil and coal for price, with boiler efficiency considered, and if he remembered it correctly, the chart showed that when oil was 7c per gallon, coal would be $8.00 a ton. He was a witness for oil.

Another man declared that they had worked it out for his plant and it was cheaper to burn coal at $15.00 per ton. He was a coal man.

Back came the man who wrote about the oil, to put the figures for his plant on the blackboard. He said he often got better than 15 lbs. of water evaporated per lb. of oil, but he would say 14 lbs.

Water evaporated per day (24 hrs.) 480,000 lbs.

Oil required 480,000÷14=34,300 lbs.

Weight of 1 gal. oil is approximately 10 lbs.

Therefore 34,300÷10=3,430 gals. are required.

3,430 gals. at 7c per gal.=$240.10 per day for oil.

He would allow that 8 lbs. of water could be evaporated per lb. of coal, therefore 480,000

---

8 x 2,000 (lbs. per ton)=30 tons of coal

$240.00÷30=$8.00 per ton for coal.

A pump was needed to put the oil in the service tank at the top of the boiler room, which was 25 ft. of a lift

34,300 lbs. x 25 ft.

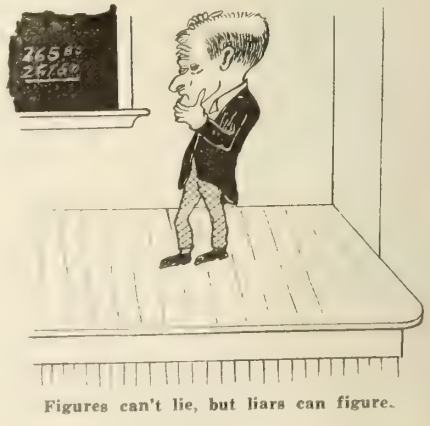
33,000 = 26 h.p. for pumping

allowing that each h.p. required 2.3 lbs. of oil

26 x 23=or say, 60 gals. to run the pump

60 gals. at 7c=$4.20 for pumping.

For steam atomizers it would take from 2 to 5% of the steam made by the boiler to break up the oil in the burners. He thought 4% was fair enough. Allowing 34.5 lbs. water for h. p. then



Figures can't lie, but liars can figure.

480,000=13,913 h.p. was developed.
———=13,913 h.p. was developed.
34.5
4% of 13,915=557 h. p. x 23 lbs. oil per h. p.
=1,280 lbs.=128 gals.
128 gals. at 7c=$9.00 for atomizing.

His labor for 3 shifts was	$ 12.00
Oil	240.00
Pumping	4.20
Atomizing	9.00
	$265.30

When he operated the same plant on coal the

Labor was	$ 21.50
30 tons of coal at $8.00	240.00
	$261.50

Evidently, he expected to show that he was making a saving with oil, for he stood scratching his head and staring at the result as though he did not understand it. If he had claimed an evaporation of 15 lbs. per lb. of oil, he would have made it come out the way he wanted it

480,000÷15=32,000 lbs.=3,200 gals. at 7c=$224.00

but he got excited and could not see that he had been too generous about the evaporation and several other things.

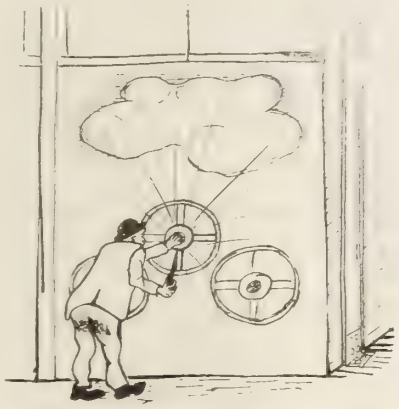
To us he made very plain the advantage of having equipment which would give that extra lb. of water evaporated per pound of oil. We would like to have the saving for a year for our salary, and we would not look for a bonus at Christmas either.

Another man who said that he burned oil in his heating plant and that he was evaporating about 150,000 lbs. of water every 24 hrs., made the statement that he had been able to show a saving with oil and he would be glad for anyone to see his records. He could show what he had paid for oil month by month and the price of coal on the same date. His records covered 3 years and he frankly admitted that the first year it would have been better and cheaper to have burned coal.

To burn the oil efficiently it was necessary to have proper equipment and first class men. After the first year, he got his furnaces right and the men trained and he got results that paid him to fire oil. We gathered from his talk that an inexperienced fireman can waste oil even more easily than a coal shoveller can waste coal. That tanks and piping had to be of the best material and well attended to because the oil would get through where water would not go. Some of the troubles he got during his first year were due to the quality of the oil unloaded on to him, and he advised us to be careful of the stuff and see that it does not contain more water and sulphur than our specification calls for.

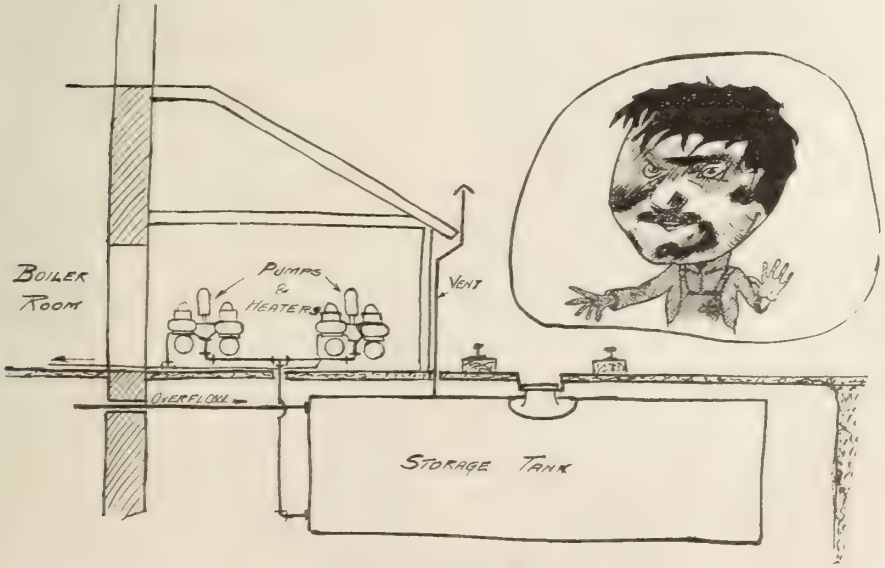
Some oil is wasteful because of the quantity of material in it which settles to the bottom of the tank. This "sludge" is practically a dead loss. It has to be thrown away because it will stop up all the burners.

Next day we went to a tech. library and hunted up all the evidence in the case of Coal vs. Oil. We found several books giving comparisons according to



Lighting Up

the writer's experience, but no two of them agreed to a dollar. One gave almost the same figures that we had on the blackboard, stating that oil at 7c was equivalent to 13,000 B. T. U. coal at $8.16 per ton (2,000 lbs.)



No Dirt With Oil Fuel.

Oil! (Leak).

One chart, by a well known firm of combustion engineers, showed that 7c oil equalled coal at $9.00, and in view of their experience we were inclined to think that their dope would be about right to follow. That is, if coal cost more than $9.00 a ton, it would be cheaper to burn oil at seven cents per gal. Imp. measure.

But we didn't leave it at that. Next day we rose up early in the morning, and still being a free citizen though on holidays, we decided to look into all the plants that we could find where oil was being used for fuel.

Oil fired plants are not so plentiful as you might think and we did not find as many as we expected. Some of the places which we were directed to had changed back to coal shortly after the war. Nevertheless, in the course of a strenuous day, we saw nine plants using oil. Six of them were strictly heating plants, only 3 of which were lighted up at the time we called, and these were running very light till frost.

Public Hospital Arrangement

The first was a public hospital and the arrangement for atomizing was operated by a motor. We didn't like it, because the power might go off and leave them without heat. The engineer claimed an evaporation of 17 lbs. of water to a lb. of oil, but he had no means for checking it, so we took his estimate with a grain of salt. He complained that the quantity of oil that the equipment would handle was limited, and he couldn't get his safety valve to blow, no matter how he pumped. We couldn't make out what the trouble was, but as there looked to be a pretty good chance that the safety valve was stuck, we made a hurried departure.

The next plant was in a hotel. Under a boiler of about 75 h.p. we found a burner of the engineer's own invention. He was rather chary of giving information about it but bragged mightily of the saving he was making for the company. We didn't want to steal his ideas, but we couldn't help but notice that the oil pump was operating around 150 lbs. pressure. The fire was dazzling white, and that made our chance to see the burner very poor, so we're not sure if there was any more to it than just an elbow, plugged and a slot sawed in it.

The inventor told us he was burning only about 200 gals. of oil per day, but the oil tank happened to be putting some in when we came up onto his street and the driver said he filled up the 500 gal. tank every other day.

That same driver directed us to go to another hotel "if we wanted to see how oil should be burned." There we found the writer of the paper on oil, who was covering reams of paper in an effort to design his methods of keeping his records for the next year. When we say he was operating all the machines necessary for "the house" we have told his story outside the boiler room. We won't try to describe the roar of those steam burners, nor the long smooth rush of the flame. It was awe inspiring but it raised a question "how about tubes." Did he replace very many? He admitted that he did put in quite a few, but he blamed it to the fact that the oil was very high in sulphur.

It seems that the sulphur in oil doesn't attack the tanks or piping like the same element in coal would attack the burners and chutes. But if the burner is set so that the flame is driven on to the tubes, then look out for trouble. His burners were pointed so the ordinary flame did not reach the tubes, but he had an idea that as the slots in the tip wore, the cone increased in size and then the drops had mass enough to affect the distance and the direction they would travel. He had to watch the tips of the burners so the cone wouldn't get too large on him. We wondered if it would be possible for the oil to come through in occasional slugs which would weigh enough to make them travel to the tubes and cause damage by burning them. We certainly admired that fire, but could easily imagine a bit of scale in the tubes would start, with a heat like that close up on the outside.

We followed the oil from the storage tank to the burners and while we found quite a few things contrary to what our reading on oil fuel had led us to expect, there were lots of nifty ideas, particularly in piping. For instance, the oil could be bye-passed so there was small chance that the supply would fail at the burners. There were steam lines for heating and for fire protection.

There was a heater around the suction pipe inside the big tank. Guess they would have had a hard time in winter to pump without that, for oil doesn't handle easily below 80° F.

Even at that temperature, it is sticky stuff and hard to pump, which perhaps explains the high cost of pumping as put on the board at the C. A. S. E. meeting.

While we were making a diagram of the tanks, pumps and piping, we discovered the man who looks after them and made a sketch of him too. And then they tell you oil is "so clean to burn."

Another Example

We stuck around that plant till we thought we had worn our welcome out,

for they started telling us of a larger one. Then of course, common decency sent us away, but really we should have gone back and thanked them, for their recommend was hardly expansive enough for the plant they sent us to.

This time the boilers were big and running at 150% rating and better. The burners atomized the oil mechanically and we were particularly requested to note the flame, that it was soft and bluish and without any definite outline to it, so there was very little chance for impingment on the tubes or damage to them.

"It's the only burner for a plant like this," declared our new friend the Chief. "Those mechanical atomizers you have seen will break up light oil well enough, but here we can't afford to pay 10c a gal. for oil. We don't pay half that, so the muck we get has to be divided into particles about one tenth the size which those little burners make it, to get the necessary surface exposed to vaporize it at the rate we want it to burn.

"We make it warm so we can pump it, and hot so it atomizes easily. All the oil passes through the heater after it leaves the pump and is about 250° F. at the burner, more or less, depending on the oil we are using.

"Our load has its ups and downs, but there is no difficulty because these burners are very flexible and we can control the quantity of oil to suit the requirements, also the air for combustion. The quantity of air is just as important as the right amount of oil, but the wicket at the burner working with the damper gives us so close a control that our CO_2 readings are always good." There was very little waste at that plant and we were not surprised at or doubtful of the claim for 80% efficiency.

The chief showed us and told us many things about oil including a story about a new man in the stores department who hailed from Texas. Of course the new man didn't know they used oil for fuel so it was a wonderful discovery to find a patch of oil on the ground, though the same oil had come from a leaky pipe.

When we opened a discussion on the price of oil as compared with that of coal, we found our new friend's weak spot. He didn't keep any record of comparative coal price. They had a long contract, so what was the use?

After we got back to our own stamping ground, we thought it all over and came to the conclusion that in times like these, when the country is full of strikes the fellow that didn't have the strike would have the cheapest fuel. In normal times the price of oil would probably be adjusted to the price of coal so nearly that it was fifty-fifty which fuel a man burned if he had equal experience with both. But if he knew one and not the other, then let him burn the one he knows best with all the care he can and he will get the desired results.

WASTE HEAT RECOVERED

Tests made at a large water-gas plant in Illinois by W. A. Dunkley, gas engineer, of the United States Bureau of Mines, using coal for No. 2 Illinois seam as generator fuel and operating with waste heat boilers, showed that approximately 12 per cent of the heat introduced as fuel was recovered by the boilers, the steam generated corresponding to about 600 boiler horse power, more than enough to operate the gas sets. Without the waste heat boilers, this energy would have been totally wasted. Recoverable heat was still going to waste.

SECOND REVISION OF A. S. M. E. BOILER CODE

(Continued from page 28)

fied in Pars. X-25, X-27 and X-28 may be made on a length in each lot of 500 or less, of each size. Each length shall be subjected to the hydrostatic test.

X-31. If the results of the physical tests of any lot do not conform to the requirements specified in Sections X-25, X-27 and X-28, retests of two additional pipes shall be made, each of which shall conform to the requirements specified.

III—Workmanship and Finish

X-32. (a) For pipe 1½ in. or under in inside diameter, the outside diameter at any point shall vary not more than 1/64 in. over nor more than 1/32 in. under the standard size. For pipe 2 in. or over in inside diameter, the outside diameter shall vary not more than 1 per cent. over or under the standard size.

X-33. Unless otherwise specified, pipe shall conform to the following regular practices:

(a) Each end of standard pipe shall be threaded.

(b) Extra strong pipe shall be furnished with plain ends.

(c) All threads shall be in accordance with the American Standard and cut so as to make a tight joint when the pipe is tested at the mill to the specified internal hydrostatic pressure. The variation from the standard, when tested with the standard working gage, shall not exceed a maximum of one and one-half turns either way.

(d) Each length of threaded pipe shall be provided with one coupling, having a clean-cut thread of such a pitch diameter as to make a tight joint. Couplings shall be of wrought iron.

X-34. The finished pipe shall be reasonably straight and free from injurious defects. All burrs at the ends of the pipe shall be removed.

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

HEATING SURFACE OF SCOTCH BOILER

Question:—Please explain in your next issue of the Power House how to figure the heating surfaces of a Scotch marine boiler?

Answer:—The heating surfaces of a Scotch marine boiler are the furnaces, from the level of the fire bars, the plates of the combustion chamber, and the crown of the combustion chamber, also the tubes. This will be practically half the diameter of the furnace, x length in feet, x number of furnaces. Add to this the area of the side and back plates of the combustion chambers, and the area of the crowns. The combustion chamber tube plate is a heating surface, but from its area must be deducted the cross sectional area of the tubes. The area of the tubes will be the outside diameter of the tubes, x 3.1416 and divided by 12, the result being multiplied by the number of tubes and the length in feet. In figuring the combustion chamber area, if strict accuracy were aimed at, the area of the stays would have to be deducted, but the error including the stays is a small one. We could say in formula form for the heating surface

$$\tfrac{1}{2}D \times 3.1416 \times L \times N + (\text{area of c. c. shuts} + \text{area of crowns} - \text{total area of tubes}) + \frac{d\ \pi}{12} \times l \times n$$

Where D = dia. of furnaces, L = Length of furnaces, N = Number of furnaces, d = diameter of tubes, l = length of tubes, n = number of tubes.

Area of tubes to be subtracted is, of course, cross-sectional area, or $d^2 \times .7854$. The combustion chambers may not be all the same size. The bottom of the combustion chambers below the bridge wall might be considered a heating surface, but as this space speedily fills up with soot, as a rule it may be neglected.

CIRCULATION OF WATER

Question:—In a recent argument between a locomotive engineer and myself re the circulation of water in bottom legs of a locomotive boiler, he argued that the water at the bottom of a boiler was not hot during any time that the steam in the boiler was at or above 212 degrees, and to prove his argument, placed an ordinary tea-kettle full of boiling water on his hand which he claimed was not hot till the steam fell below 212 degrees. I claim that owing to the water being expanded to a large degree at this temperature, and the bottom of the kettle being hot, the water barely touches the bottom before it turns to vapor; this vapor rises to the top until the temperature falls below 212 degrees, and then the water lies stationary on the bottom of the boiler or tea-kettle, when the dead heat of the water is transferred to the plates.

Answer:—Circulation in a boiler, or tea-kettle if you will, occurs from the bottom, or the portion in contact with the flame, towards the top, in a vessel such as a tea-kettle the circulation being in fairly straight lines. In the tea-kettle the water being at atmospheric pressure, boils at 212 degrees and in raising steam on a boiler the initial raising of steam takes place at atmospheric pressure. As the pressure increases the temperature of the steam and the water both increase. If the containing vessel is of such construction that ample circulation spaces are provided, the temperature all over the boiler will be approximately the same, but in a vessel such as a locomotive boiler, with its restricted water legs, circulation is not so free. It is thus possible that water may remain in the water legs and fall below the temperature due to its pressure, and if the circulation is very poor, with the bottom of the water leg below the fire grates, the temperature may fall below the boiling point. The same thing occurs in the marine type of boiler, if special care is not taken to ensure thorough circulation while steam is being raised. In the horizontal type of boiler, which may be compared to the tea-kettle, inasmuch as the flame is directly beneath the boiler plate, there is no possibility of the water falling below the temperature of the steam, but on the other hand it may be slightly higher. It is a source of considerable surprise to us that your friend was able to place a kettle full of boiling water on his hand, unless he had taken special precautions to avoid burning beforehand. If as you surmised, there was no water in contact with the bottom of the kettle, then the kettle would burn, as steam is a very poor conductor of heat. It is owing to the fact that the water by rapidly circulating carries away the heat that is passing through the thin plate and distributes it to the rest of the water that burning of the plate is avoided. As the hot water rises from the bottom of the kettle or boiler it does so in the form of a small bubble, enclosing a small amount of vapor, this bubble increasing in size as it reaches the surface, where the pressure becomes less. When the surface is finally reached the bubble bursts, and its vapor content goes to join the steam in the steam space. If you were to leave a kettle long enough exposed to the flame the water would eventually be all evaporated in this way, and there would be nothing to carry away the heat from the metal except radiation, which could not carry it away rapidly enough to prevent the metal becoming red hot, and if sufficient heat available, melting.

You may or you may not be aware of the fact that water can be boiled in a paper bag over a gas jet, providing the flame is not so severe as to pass heat through the paper faster than the water can carry it. Water is not a good conductor of heat, but is a very good carrier, and the circulation of water distributes heat by conveying it. If you fill a bath with cold water, and then turn the hot water tap on you will notice that unless you take means to mix the water up by stirring with your hand, there will be a distinct zone of hot and cold water. In the case of the water leg of a locomotive boiler, the greatest heat is above the fire, which heat is carried by the water in the upper part of the leg by convection up towards the crown sheet and from there towards the barrel of the boiler. In this way it is quite possible for the bottom of the water leg to contain water that has little or no circulation, and this would account for the difference in temperature at this point.

SIZE OF PISTON RINGS

Question:—How are the proper sizes of piston rings arrived at; in what proportion are they made larger than the diameter of the piston or cylinder bore, say, for 3, 4, or 6 inch cylinders? Also how is the efficiency of the ligaments between the tubes of a boiler arrived at so that part of a boiler will be equal in strength to the rest of the boiler?

Answer:—A fairly good rule to use is that the diameter of the ring before cutting should be equal to the diameter of the cylinder plus diameter x .03. Thus with a 4-inch cylinder the ring before cutting would be $4 + 4 \times .03 = 4.12$, which is practically 4⅛. The circumference of the ring will be then longer than the circumference of the cylinder by $.125 \times 3.1416 = .3927$, and this will

be the amount to be cut out approximately. When turning the ring it should be turned with the inside diameter slightly eccentric to the outside, which allows the ring more ease in springing in, than when it is parallel. Using the same rule for a 6-in. piston we would have $6 + 6 \times .03 = 6.18$ dia., which is practically 6-3/16 dia., and a 3 in. ring would be $3 + 3 \times .03 = 3.09$ or 3-3/32 dia. before cutting.

Boiler Tube Ligaments

The strength of the ligaments between the tubes of boilers, when the tubes are in a line parallel to the axis, such as in some types of water-tube boilers, is found by the formula $\frac{P - D}{P}$ = efficiency where P is the pitch and D the diameter of the tubes. The size of the ligament between tubes in a horizontal boiler head must be .3 of a square inch in sectional area, or ¾ in. linear measurement, whichever gives the greatest pitch.

WHAT'S THE ODDS

Just to show how some of the towns in the United States are indifferent to a mere shut-down of a power plant, I was in a city not long ago whose population is about 4000. They have an electric light plant municipally owned, but at 11 o'clock p.m. they shut down, that is, provided they didn't shut down before 11 p.m. In the meantime, to dispel darkness the denizens of the city have to content themselves with matches, candles, kerosene or moonlight.

While I was in that town in a hotel, I noticed that my light was gradually growing dimmer and finally it died down altogether at nine o'clock. Much disturbed I lighted a kerosene lamp which had been provided. I noticed that everybody else was unconcernedly providing light of some kind without cursing or loud talk of any kind. I was the only one who seemed inclined to worry about the situation.

I inquired as to what might be the matter, but no one would venture an opinion on the subject. "It ain't nothin' unusual," I was told.

Disliking the idea of reading by kerosene lamp. I strolled over to the power house to get my information first hand. There I found the fireman just closing up, locking the door. "What's the matter?" I asked. "Nothin'." he drawled. "Why did you shut down so early?" "Ran out of coal." "Why didn't you borrow some?" "'Twa'nt necessary. We're expectin' a car some time tomorrow."

ANNOUNCEMENT

The Beldam Asbestos Packing & General Manufacturing Co., Toronto, have completed arrangements with the Crane Packing Co., of Chicago, for the manufacturing of their products in Toronto. They also handle the selling for the Crane Company in conjunction with their own business.

Should Piston Rods Be Ground?

WHEN the question of the installation of new equipment comes before the management of manufacturing plants to-day, the modern executive requires to be shown the advantages that will be derived by the proposed change of practice before deciding on the best machine for the purpose. Owing to the many factors to be considered it is frequently desirable to exercise a reasonable degree of caution before committing one's self on the adoption of any particular style of equipment.

While there is still some difference of opinion regarding the most efficient method of truing both new and used piston rods, extended tests seem to favor the grinding process. As an instance of the study that has been given to this phase of railway practice the following extract of an article in the Railway Mechanical Engineer may be of interest:

"Notwithstanding the almost universal approval of piston rod grinding, the innate caution of railroad men regarding new devices was strongly illustrated in a large railroad shop recently where it was proposed to install a machine to grind piston rods instead of continuing the older method of turning and rolling them. Those who hesitated to install the new machine said that it must first demonstrate its superiority in a comparative test. Accordingly, a new piston rod was turned and rolled as accurately as possible. This rod was then carefully mounted in a piston rod grinder and ground, with the abrasive wheel just lightly touching the rod. The grinding operation was then stopped and observers noted that more metal was removed at certain places on the piston rod than at others and in some places the abrasive wheel did not touch the rod at all.

"Micrometer calipers checked the accuracy of grinding both as regards taper and roundness of the rod. The fact that more metal was removed by grinding at certain places than at others proved conclusively that the rod, as rolled previous to grinding, was not a true cylinder. This was evidently due to the fact that the rod was non-homogeneous, being softer in some spots than in others, with the result that the roll depressed these soft spots unduly. The grinding machine, on the other hand, exerted hardly any pressure on the rod and removed as much metal from the soft spots as the hard, producing a true cylindrical surface.

"In the days of wick packing the accuracy of piston rods did not make so much difference, but now that metallic packing is used almost universally it is evident that this packing cannot hold steam and last for any considerable length of time unless piston rods are accurately round, smooth and, practically speaking, without taper. That these qualifications are best obtained by the use of modern piston rod grinding machines is evident from the many ground piston rods now in daily use and giving satisfactory service."

USE OF STEAM IN COAL GAS RETORTS

The tendency toward lower standards of quality of gas in public utilities has increased the interest of the gas industry in processes that promise to increase the yield of gas per pound of coal coked, even though attended by a decrease in quality. The introduction of steam during or at the close of the coking process has shown considerable advantage in certain types of gas-making installations, notably in vertical retorts. The Bureau of Mines, through W. A. Dunkley, gas engineer, has co-operated with the American Gas Association in studying the effects of using steam in horizontal retorts, which are commonly used. It was found that the method of admitting steam had much to do with the results obtained. Little, if any, water gas was generated by decomposition of steam in the retort charge, unless the contact between the steam and the charge was intimate. Steam as usually practised in the small gas plant, where the process had been tried, has no advantage. With prevailing standards of gas quality, little advantage can be taken of the use of steam, even if properly applied, as the production of any appreciable volume of water gas considerably reduced the general quality of the total gas production. Should standards be further reduced, the process might show more marked economies.

HEAT FLOW IN COAL

In connection with a study of the flow of heat in coal, being made by the Bureau of Mines at its experimental coal mine near Pittsburgh, Pa., the problem of determining the rate of flow of heat from the ventilation air into the coal at the experimental mine has been attacked by making use of a standardized flow plate inlaid in the coal walls of the mine. This plate consists of a sheet of lead ¾ of an inch in thickness and three feet in diameter. Thermocouples mounted in the opposite faces of this plate enable the operator to determine the temperature gradient across it, and, knowing the thermal conductivity of the lead, the quantity of heat flow into or out of the coal follows immediately. The conductivity of the coal is also computed by using these data, together with the temperature gradient in the coal. This gradient is found by means of a large number of thermocouples which are located at various positions in the mine wall.

The Operators' Point of View

HOW MUCH FUEL DOES A CLEAN BOILER SAVE?

By W. F. S.

Here is an interesting and valuable chart for finding the fuel saved by keeping boilers clean. Simply zigzag across the chart three times with a straightedge or fine black thread, as indicated by the dotted lines drawn across, and the per cent. of fuel saved is found in the last column at the right—Column G.

For example, if the temperature of the chimney gases before cleaning was 580 deg. F., and after cleaning 480 deg., and if the heat value of the coal is 12,000 b.t.u. per pound, what is the percentage of fuel saved?

Connect the 580 (column A) with the 12,000 (column C) and make a note of the figure intersected in column B. In this case we find the figure in column B to be 70 per cent. Now begin at the 12,000 (column C) and run a line through the temperature difference (before cleaning and after) in column D, which is easily figured to be 100 deg. Continue the line until it intersects column E. Column E, you will note, is intersected at 3.8 per cent. Now from this point (column E) run through the figure in column F, which is the sum of the figures obtained in column B and E. In this example the sum is (70 plus 3.8 per cent.) 73.8 per cent. The continuation of this last line through column G gives the answer as 5.15 per cent.

The instructions on the chart itself tell just what to do as you go along. Each column is fully explained, excepting column B and E, which are to be added together for use in column F. In zigzagging across, the second line from column C to column E begins where the first line ended—at the 12,000 b.t.u., the 13,000, or whatever it happens to be. In this example it is 12,000 b.t.u. In the same way the third line, from column E to column G, begins where the second one ends. The writer has experimented with this chart to find which is quicker—the chart itself or the formula on which the chart is based. In every instance I found the chart to be much quicker. The only mathematical operation involved—adding two simple numbers—requires very little time or thought and can frequently be done mentally.

Not long ago I developed and published a formula for computing the fuel saved by cleaning boilers. This formula met with considerable approval. One correspondent, however, asked if I could alter the formula and get rid of the "boiler efficiency factor" which was contained in the formula. Many operators of boilers haven't an inkling regarding their boiler's efficiency, and as soon as one begins to talk efficiency to them they shrug their shoulders and give up the task as hopeless. With this correspondent's suggestion in mind I sought out some good representative steaming tests where I knew the firemen and engineers did the best they could and derived this formula:

$$\frac{100\,(T-t)}{0.22H-0.37T-t} =$$

Per cent. of fuel saved, assuming 18 pounds of air per pound of fuel.

Where

T=the temperature of the chimney gas before cleaning;

t =temperature of chimney gas after cleaning, deg. Fahr.;

H=heat value of fuel in b.t.u. per pound.

This is the formula upon which the chart is based. It contains three most important factors, all of which are usually known or determined without great effort. T and t can be found by means of a pyrometer or a thermometer properly placed in the gases. If a thermometer is used don't place it close to any comparatively cool body or the bulb will radiate heat so rapidly as to affect the reading considerably. The heat value of the coal, H, can be ascertained with fair accuracy from Bureau of Mines publications, which list the heat values of coals mined all over the United States. Naturally the chart is subject to criticism. It is not claimed to be perfect. No boiler efficiency formula can be expected to be perfect, containing only three factors, as this one does. It is simple, however, and that is a thing that is always wanted. It shows clearly that a cleaning operation should reduce the temperature as much as possible. The lower the final temperature the better. It also shows that it is desirable to use high-quality coal—coal of high heat value. The lower initial temperature and the higher heat value of the coal, the more difficult it is to save coal, because under such conditions the efficiency of the boiler is already high.

The range of this chart is great enough to include most boilers. The efficiencies range from 50 to 100 per cent. The maximum temperature decrease is 200 deg. F., which is sometimes exceeded but seldom is an average decrease. Column G shows that the chart will compute savings all the way from 2 to 15 per cent. Should your problem be so unusual as to fall outside of this chart, which is improbable, recourse may be had to the formula which is given above.

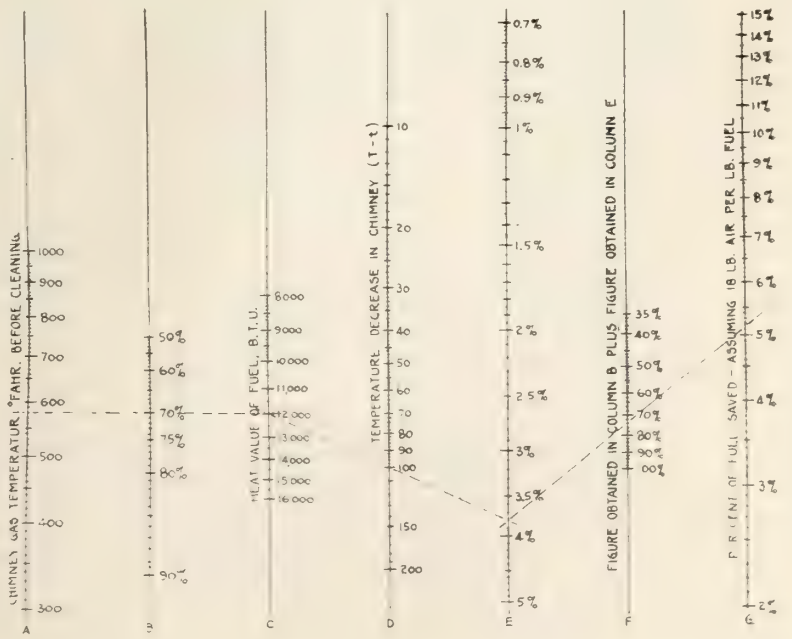


Chart for finding the consumption of fuel.

Requirements of a Good Bearing Metal

THE relative value of a bearing metal is not to be judged by its composition and physical properties alone. Many other factors, which are frequently overlooked, should enter into its selection. For instance, the lower specific gravity of the tin-base metals, and the fact that they can be used to advantage in very thin linings, should make them the logical selection for many bearings in which a lead-base metal is now used.

Again, allowance is very rarely made for the losses which occur in the melting and remelting of many metals. A babbitt of properly balanced composition, which is carefully alloyed from strictly virgin materials, should give very little dross and be remelted without serious loss of either metal or properties. Unfortunately, however, the use of virgin materials in the manufacture of babbitt is the exception rather than the rule, and any apparent saving recoils heavily on the head of the purchaser. The loss in melting babbitts made from reclaimed metals is frequently as much as 6 per cent. This item alone, with a fair allowance for melting cost and overhead, increases the actual cost of the metal by fully 10 per cent., to allow nothing for the sacrifice of bearing properties inevitable to the substitution of reclaimed for virgin metals.

While it is difficult to secure bearings of perfect uniformity from babbitts alloyed in the customary manner, the difficulty is magnified a thousand fold when reclaimed metals are used, and if the purchaser is buying bearing service rather than so many pounds of metal he does not get what he pays for. In service, the most obvious, but by no means most important, requirement of a babbitt is that it should have sufficient strength and hardness to carry the load with a reasonable factor of safety. The physical properties of a babbitt are valuable only in determining that it will meet this requirement and it should be borne in mind that they normally give very little, if any, indication of the performance of the metal in other respects. The compressive strength and Brinnell hardness tests do, however, serve as an excellent guide to the uniformity of metals of the same analysis.

The tensile strength and elongation of a metal are valuable as indicating its ability to withstand repeated shocks and pounds without cracking or fracturing, and are more important than the compressive strength and hardness in metals which are to be subjected to a pounding action or are to be poured into very thin linings. It is when abnormal conditions are encountered that the true requirements of a babbitt become apparent. In the majority of machines the bearing surfaces are normally separated by a film of oil, and were this condition to continue indefinitely, sufficient strength to carry the load would be the sole requirement of a bearing. There is, however, as will be discussed later, an ever present liability to separation of the oil film which cannot be foreseen or prevented. This breakage of the film may be due to many causes; temporary or permanent failure of the oiling device, the introduction of foreign matter, heavy overload, etc.

Immediately the oil film breaks, the journal and bearing come into contact and heat is generated due to the friction. How soon this heat may become sufficient to cause failure of the bearing depends entirely upon the true bearing properties of the babbitt. As in ninety-nine cases out of one hundred the separation of the oil film is temporary rather than permanent these properties are of extreme importance. It will be realized from the above that the metal is best which most fully combines the following properties:

(1) A tendency to hold the oil film when extraneous conditions are tending to separate it.

(2) A low coefficient of friction, to reduce the quantity of heat generated.

(3) Relatively high heat conductivity, to more rapidly convey the heat from the point at which it is generated.

(4) Ability to continue to carry the load at abnormal temperatures.

A consideration of the requirements outlined above is as essential to the intelligent selection of a babbitt as its more obvious physical properties, and they are even more deserving of the attention of the engineer.

THE HUMAN EQUATION

By John Scotch

Tell the average man upon the street that a certain steam boiler has had a new safety valve attached to it and he is convinced this boiler is protected against explosion. The dangers of the power plant, operated by steam pressure, have been brought to the attention of the public on numerous occasions without leaving any impression. They do not realize that a safety valve is one in name only unless it is large enough to carry away the steam as fast as a boiler can generate it, and that it is always in perfect condition to operate.

About the most reliable safety machine in a power plant is a careful, capable engineer. With a careless and inexperienced engineer in charge all mechanical safety devices can degenerate through neglect or ignorance into devices of danger. No fool-proof safety device has ever been made for the power plant although there are many so called ones. I have always held the opinion that in the examination of engineers for certificates the most important points should be the character and reputation of the applicant as an engineer. In a great many examinations the applicant is compelled to give a list and description of the plants he has been employed in. I venture to state that very often his unsupported statement is taken in the matter, and that no real effort is taken to verify his statements. I knew a man who passed an examination and secured a certificate (not in Ontario under the present Act) by answering the questions, and he had been employed in a power plant for some years. This man told me later that the only work he had done for the power plant was to deliver wood to it. Because a man has worked in several large plants totaling some years does not mean that he is a safe man. Proper investigation might show that his experience and knowledge would count as little against his many defects such as laziness, carelessness, lack of human understanding, etc. The man in charge who, to use a slang expression, gets the goat of his helpers, is a dangerous man so far as securing the best out of workers is concerned. It matters little how much knowledge he possesses along other lines. A man who has much less mechanical knowledge but who is faithful to his employer and can get the whole-hearted support of the men under him is in my opinion the safer man of the two. The educated man can save his employer money by his expert advice when new equipment is to be bought or installed and in other ways, but there are quite as many ways he can cause his employer to lose money, unless he secures the faithful co-operation of the men under him.

CARE OF GAUGE GLASSES

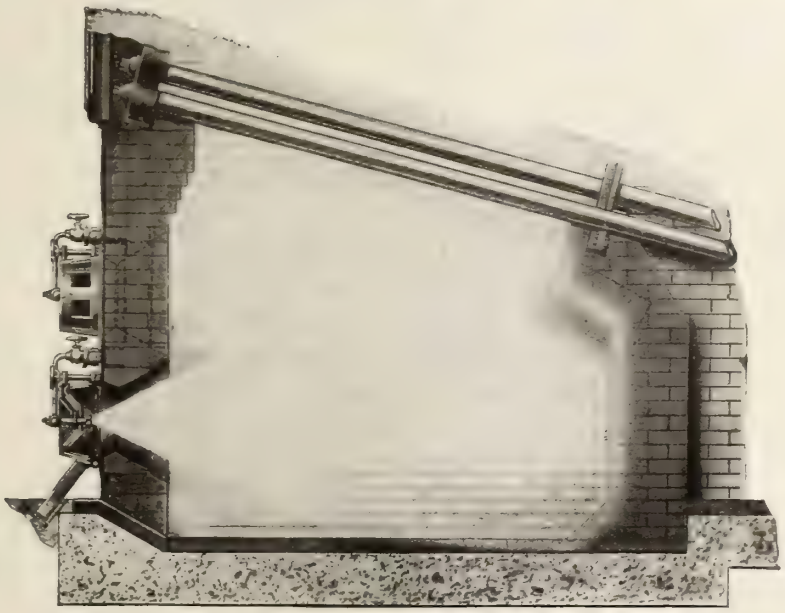
By J. James

Gauge glasses are an important item in the power plant. It is strange therefore how careless some men are in storing them, even hanging them up by running a wire through them. When it is considered how sensitive the interior of such glasses are it is not to be wondered at that when treated so roughly they break quickly in service. I have seen gauge glasses bare of covering dumped into a box and every time the box was moved, which was every time anything else was required out of the cupboard in which the box was kept, it was roughly pushed aside. This would make the glasses roll around against and over each other. When storing gauge glasses each glass should be carefully wrapped in paper to prevent them coming in contact with each other or any hard material. Note how such glasses come from the dealer. They are wrapped tightly in paper.

Some men advise leaving the water in gauge glasses where no night man or watchman is employed. Numerous instances have been recorded where a glass has broken during the night, and often such plants have the fires banked at night, a small steam pressure being carried to supply heat for some purpose. Imagine the result of a broken glass in such a case. Perhaps thousands of dollars worth of damage done to goods. The

BABCOCK & WILCOX

OIL BURNING EQUIPMENT



Babcock & Wilcox furnace for burning oil fuel only

The merits of oil as a fuel for steam generation, in places where its cost compares favorably with coal or wood, are, briefly, the following:—

1. An increase in boiler efficiency, owing to the clean condition in which the boiler heating surface can be maintained, and the completeness of combustion obtainable with a good system of oil firing.
2. A constant and equal distribution of heat in the furnace, and, as there are no fire doors to be opened, the cooling effect of a large volume of air passing over the furnace is avoided.
3. A reduction in the cost of handling the fuel, as this can be done by a pump; and a large reduction in manual labor, the firemen not being required as they would be for ordinary fuels. One man can regulate the burners of a considerable number of boilers.
4. No wear and tear of grate bars.
5. No dust, no ashes, and no clinker.
6. When once arrangements have been made, the storage of oil fuel is simpler than the storage of coal, and oil does not deteriorate.
7. The control of the steam production is easier, more effective and more rapid than with solid fuels.
8. Instantaneous ignition, and extinction of the fire.
9. No smoke.

The three main systems for burning oil fuel are:—

1. That in which STEAM is used as a spraying or atomizing agent.
2. That in which AIR is used for this purpose.
3. That in which the oil is atomized mechanically by PRESSURE.

We would be glad to go into details with a prospective purchaser.

BABCOCK & WILCOX, LIMITED

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE, BANK OF HAMILTON BUILDING

dead reason advanced for leaving water in a glass at night is that some fireman might start a fire and forget to open the gauge glass valves. Any man who will break and limber up a banked fire without first looking at the glass and making sure the water is o.k would be either full of home brew, a fool, or a man ignorant of power plant work. Such a man would be all right throwing in cordwood to burn bricks in a yard. Gauge glass cocks are in the same class as water column cocks in one respect anyhow, they should be tested often.

PULLEY AND GEAR SIZES

By F. C. M.

After careful reading of article re Lever Pulleys and Gear Drives, I might offer a more simple formula to determine different speeds as, in my estimation, the knowledge of algebra is not necessary. All that is required is the knowledge of multiplication and division.

The following rule has been followed by the writer during his forty years' experience on construction work, and has never resulted in a mistake on speed, both on pulleys and gears.

For gears we may take the pitch diameters and figure them the same as pulleys but the more accurate way is to multiply the number of cogs on the driver by the revolutions of the shaft and divide by the number of cogs on the driver. It amounts to the same thing but seems to me a much simpler way.

The same rule is applied on pulley drive. Multiply the diameter (in inches) of the driver by the number of revolutions and divide the product by the diameter of driver, the result of which will be the speed of same, or if a desired speed is required, multiply the diameter of driver by the number of revolutions and divide by the number of revolutions required, hence the size of the pulley.

Re quarter-turn or right-angle drives, an invariable rule which is very simple is to set the two discharging centres in line, or plumb if a vertical drive.

MAKING MISTAKES

By J. Gelethorne

A week or two ago a chief operating engineer became acquainted with my son while attending the Toronto technical school. He informed my son he had read a number of my letters and articles in Power House and other technical journals, and that he had noted ideas and suggestions in some of these articles which he considered not altogether correct according to his point of view. It is quite possible his point of view is right and mine wrong. I have written hundreds of articles for publication during the past twenty years and I would be an engineering superman if some of these articles did not contain flaws. The Editor of an engineering journal would be one of the wonders of the world if no mistakes got past him and into print. There is one man I would imagine the editor is always pleased to have a letter from, that is the lad who notes some mistakes or misstatements printed in the journal and directs the editor's attention to it thus giving him a chance to put the matter right with his readers. Apparently trivial mistakes can cause a lot of trouble, and especially so in engineering. A writer should be very sure of his case before he submits it for publication. The serious misstatements seldom get past the editor's observation, but he is only human like the rest of us and has to relax sometimes. It appears strange but seems true, whether in engine or editorial room. Fate uses these moments when we cease to be alert to put something over on us, probably fate is doing us a good turn in a left handed way. When we are notified about these mistakes it has a tendency to reduce our stock of self-conceit to its proper level. This illustrates the great benefit writing for his power plant journal is apt to be to the engineer. It teaches him to carefully investigate before writing or deciding, this is the reason you cannot teach others without teaching yourself.

RE ENGINEER'S LICENSES

The Editor, "Power House,"

Sir:

Could you spare me a few lines of your paper to enquire as to the following:—What class of papers does it take to operate a heating system, say for instance, a 75 h. p. r. t. boiler carrying 10 or 15 lbs of steam? I would like to inform my brother engineers that there are lots of heating systems in Toronto that are being operated by men without certificates. Should a man be allowed to operate a steam boiler and do the general work around a plant and defy all law? Why not have inspectors the same as they have for anyone carrying a bottle of liquor on the street? The laws are all made by the same people, and who is supposed to see that the law is enforced? I was talking to a man the other day who has charge of a building in the centre of the city of Toronto, and he had no Ontario license to operate a boiler. He said he had an Ohio paper that was better than a chief's here. Now could an engineer from Toronto go to Ohio and tell the engineers in America that he had a ticket superior to theirs and get away with it? Yet the unions and the C. A. S. E. are giving educational classes to improve the engineer, and the ones that are really keeping the office at the top of Spadina are the ones to pay for it all, and yet anyone can get an engineer's job in the city for heating buildings and sprinkler tanks without a license of any sort. I may seem a little pessimistic, but if needs be I can show you lots of engineers out of a job, that have paid for their certificates, and as long as they keep paying their renewal every year, and as long as there is enough paying to keep those fellows in their jobs, they have no need to worry.

SECOND CLASS ENGINEER.

We publish the above letter not because we in any way agree with the writer, but simply because if we did not publish it, the writer would feel that his complaints are so well grounded that he could not get fair play, etc. From our personal knowledge we know that the Board of Examiners are doing all that is humanly possible to carry out the law, and if any man knows of an instance where it is being violated, it is his duty to bring it to the attention of the Board. It is a considerable time since we have heard any complaints such as the above, though at one time they were very frequent. We attribute the decrease to the fact that the engineers in the province are becoming acquainted with the work the Board is doing. As a matter of fact the writer of the above should know that where the pressure carried is below twenty pounds per square inch no certificate is required by law. The wisdom of this may be open to question, but the law is as it stands. We would advise our correspondent to go up to Spadina Avenue and have a talk with the gentlemen connected with the Stationary Engineers' Board, and we guarantee he will come away with a much better opinion of them and their work than he seems to have at present. —Editor.

A bulletin has been issued by the Laclede Christy Clay Products Co., St. Louis, describing the installation of the Laclede Christy stokers in the Kansas City plant of Armour & Co. The booklet contains a number of illustrations, and complete performance data is given, which should be of interest to stoker users in general.

The Reliance Gauge Column Co., have disposed of the Cleveland Clutch business to the Western Engineering and Manufacturing Co., 360 Grand Avenue, Chicago, and will devote their energies in future entirely to the manufacture of the steam specialties with which they are identified. These include safety water columns, steam traps, seamless floats, etc.

SPONTANEOUS COMBUSTION OF COAL

At the Pittsburgh, Pa., experiment station of the United States Bureau of Mines, J. D. Davis, fuels chemist, and J. F. Byrne, research fellow, Carnegie Institute of Technology, have investigated the relative tendency of Pennsylvania coals to ignite spontaneously. The research consisted largely in the development of methods for the determination of the comparative sensitivity of coals to oxygen. A study was made of the comparative sensitivity of coal constituents of oxidation in co-operation with Dr. H. Thiessen, research chemist, the coal constituents being separated by the aid of a microscope.

POWER HOUSE BUYERS' DIRECTORY

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Jointless Fire Brick Co., Chicago, Ill.

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Can. Johns-Manville Co., Ltd., Toronto.

ASBESTOS SPECIALTIES
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Can. Johns-Manville Co., Ltd., Toronto.
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Durabla Mfg. Co., New York, N. Y.
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Pratt & Cady Co., Inc., Hartford, Conn.
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AUTOMATIC MECHANICAL STOKERS
Canadian Planet Engineering Co., Windsor, Ont.

AUTOMATIC DAMPER CONTROLS
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H. Mueller Mfg. Co., Limited, Sarnia, Ont.
Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

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Jas. Morrison Brass Mfg. Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.
D'Este Co., Julian, Boston, Mass.

BAKERS' OVENS AND REPAIRS
W. R. Sexton Boiler Setting Co., Toronto.

BAROMETERS
Taylor Instrument Co., Toronto, Ont.

BATTERIES AND ACCESSORIES
Canadian Johns-Manville Co., Ltd. Toronto.

BEARINGS
Kerr Engine Co., Walkerville, Ont.
Philadelphia, Pa.
Canadian Sirocco Company, Ltd., Windsor, Ont.

BEARING METALS
Beveridge Supply Co., Montreal.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

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BELLS
Jas. Morrison Brass Mfg. Co., Toronto.

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D. K. McLaren Limited, Montreal, Que.
Dominion Belting Co., Hamilton, Ont.
Shell Bar Boico Supply, Ltd., Toronto.

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BELT TIGHTENERS
Waterous Engine Works Co., Brantford

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BELTING, CHAIN
Can. Link-Belt Co., Toronto, Ont.

BELTING, CONVEYOR
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BELTING, GRAIN ELEVATORS
Gutta Percha & Rubber, Limited, Toronto.

BELT LACING
D. K. McLaren Limited, Montreal, Que.

BELT LACING MACHINES
D. K. McLaren Limited, Montreal, Que.

BELTING LINK
D. K. McLaren Limited, Montreal, Que.
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Gutta Percha & Rubber Limited, Toronto.
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Dominion Belting Co., Hamilton, Ont.

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BELTING, SOLID WOVEN
D. K. McLaren Limited, Montreal, Que.

BELTING, TRANSMISSION
Gutta Percha & Rubber Co., Limited.

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Waterous Engine Works Co., Brantford.

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Arthur S. Leitch Co., Ltd., Toronto.
MacGovern & Co., Inc., Montreal, Que.
Sturtevant Co., B. F., Toronto, Can.
Sexton Boiler Setting Co, W. R., Toronto

BLOWERS, CENTRIFUGAL
Sturtevant Co., B. F., Toronto, Can.

BLOWERS, FORCED DRAFT
Arthur S. Leitch Co., Ltd., Toronto.
B. F. Sturtevant Co., Boston Mass.

BLOWERS, MECHANICAL SOOT
Diamond Specialty, Ltd., Windsor, Ont.
The Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINE
Canadian Sirocco Co., Ltd., Windsor, Ont.
Arthur S. Leitch Co., Ltd., Toronto.
Sturtevant Co., B. F., Toronto, Can.

BOILER BAFFLE WALLS
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Can. Johns-Manville Co., Ltd., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
W. R. Sexton Boiler Setting Co., Toronto

CORD CLOTHING
D. K. McLaren Limited, Montreal, Que.

CHAIN WHEELS
The Mason Regulator & Eng., Co., Ltd. Montreal.

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link-Belt Co., Toronto, Ont.

BOILERS
Gelinas & Pennock, Reg'd., Montreal.

BOILER COMPOUNDS
Beveridge Supply Co., Montreal.
Can. Fairbanks-Morse Co., Ltd., Montreal.
Canadian Johns-Manville Co., Ltd., Toronto.
J. A. Carruthers, Toronto, Ont.
Sexton Boiler Setting Co., W. R., Toronto.
Shell-Bar Boico Supply Ltd., Toronto.

BOILER FRONTS
Leonard & Sons, Ltd., E., London, Ont.
Victoria Foundry Co., Ltd., Ottawa.

BOILER SKIMMERS
Sexton Boiler Setting Co., W. R., Toronto
Yarnal-Waring Co., Philadelphia, Pa.

BOILER REGULATORS
Sexton Boiler Setting Co., W. A., Toronto.

BOILER COMPOUND FEEDERS
Can. Fairbanks-Morse Co., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Fisher Governor Co. (Inc.), Marshalltown, Iowa.

BOILER FITTINGS
Crane Ltd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
W. R. Sexton Boiler Setting Co., Toronto.

BOILER FEED CONTROLLERS
Northern Equipment Co

BOILER RETURN TRAPS
Grant E. Cole Co., Toronto, Ont.

BOILER SETTINGS
Beveridge Supply Co. Ltd., Montreal, Que.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Cole Co., Grant E., Toronto, Ont.
Sexton Boiler Setting Co., W.R., Toronto.
Jointless Fire Brick Co., Chicago, Ill.
C. B. Turner, Toronto.

BOILER METAL TREATMENTS
Beveridge Supply Co., Montreal.

BOILER MOUNTINGS
Babcock & Wilcox Ltd., Montreal
Can. Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCullough Co., Galt.
Leonard & Sons, Ltd. E., London, Ont.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
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BOILER HOUSE ACCESSORIES
Babcock & Wilcox Ltd., Montreal.
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Can. Johns-Manville Co., Ltd., Toronto.
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Arthur S. Leitch Co., Ltd, Toronto.
Gelinas & Pennock, Reg'd., Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
Sexton Boiler Setting Co., W. R., Toronto.
Yarnall-Waring Co., Philadelphia, Pa.

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Crane's Limited, Montreal.

BOILER SETTING CEMENT
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Betson Plastic Fire Brick Co., Inc., Rome.

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The Mason Regulator & Eng. Co., Ltd., Montreal.
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
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Babcock & Wilcox, Ltd., Montreal.
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Shell Bar Boico Supply Ltd., Toronto.
Gelinas & Pennock, Reg'd., Montreal.

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Yarnal-Waring Co., Philadelphia, Pa.

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MacGovern & Co., Inc., Montreal, Que
Northern Crane Works, Walkerville
Mackinnon Steel Co., Ltd., Sherbrooke, Q
Waterous Eng. Works Co., Brantford, Ont.

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Waterous Engine Works Co., Brantford.

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Frick Co., Waynesboro, Franklin Co., Pa.
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Garlock Packing Co., Hamilton, Ont.

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Can. Fairbanks-Morse Co. Ltd., Montreal

COUPLING, FRICTION
Can. Link-Belt Co., Toronto, Ont.

COUPLINGS, SHAFT
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Northern Crane Works, Walkerville, Ont.
Smart-Turner Machine Co., Ltd., Hamilton

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Northern Crane Works, Walkerville, Ont.

CRANES, PORTABLE
Can. Link-Belt Co., Toronto., Ont.
Northern Crane Works, Walkerville, Ont.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.
Babcock Crane Works, Walkerville, Ont.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

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Gutta Percha & Rubber Co., Ltd.

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Under-feed Stoker Co., of Canada, Ltd., Toronto, Ont.

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Johns-Pratt Co., The, Hartford, Conn.

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Mason Regulator & Eng. Co., Ltd., The, Montreal.
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York Manufacturing Co., York, Pa.
Taylor Instrument Co., Toronto, Ont.

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Jamieson Cold Storage Door Co., Hagerstown, Md.

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Schaffer & Budenburg Mfg. Co., Brooklyn, N. Y.

DRIVES, CHAIN
Can. Link-Belt Co., Toronto, Ont.

DROP- FORGINGS
J. H. Williams & Co., Brooklyn, N.Y.

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Canadian Sirocco Co., Ltd., Windsor, Ont.

DYNAMOS
Can. Fairbanks-Morse Co., Ltd., Montreal.

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Canadian Johns-Manville Co., Ltd., Toronto, Ont.

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Gelinas & Pennock, Reg'd, Montreal.
B. F. Sturtevant Co., Boston, Mass.

ELECTRICAL MATERIALS
Can. Johns-Manville Co., Ltd., Toronto.

ELEVATORS
MacKinnon Steel Co., Ltd., Sherbroke.

ELEVATING MACHINERY
Can. Fairbanks-Morse Co., Ltd., Montreal
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

ELEVATORS AND BUCKETS
Can. Link-Belt Co., Toronto, Ont.
MacKinnon Steel Co., Sherbrooke, Que.

ELEVATING AND CONVEYING MACHINERY
Can. Link-Belt Co., Toronto, Ont.

EMERGENCY CUT-OFF VALVES
Underfeed Stoker Co., of Canada, Ltd., Toronto, Ont.

ENAMELWARE
Jas. Morrison Brass Mfg., Co., Toronto.
H. Mueller Mfg. Co., Limited, Sarnia, Ont.

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Frick Co., Waynesboro, Franklin Co., Pa.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Goldie & McCulloch Co., Galt.
Engineering and Machine Works of Canada, Ltd., St. Catharines, Ont.
Leonard & Sons, Ltd., E., London, Ont.
Waterous Engine Works Co., Brantford.

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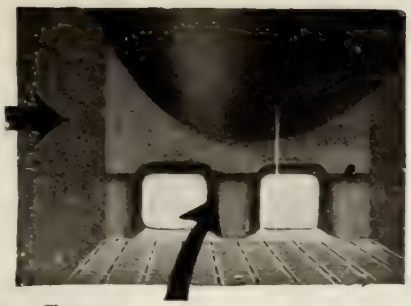

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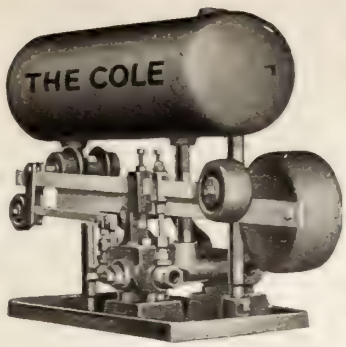

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EDUCATIONAL FEATURES STRESSED IN POWER EXPOSITION

The National Exposition of Power and Mechanical Engineering will open at 1.00 p.m. on Thursday, December 7, 1922, at the Grand Central Palace. It will immediately follow the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers and will remain open until December 13th, except on the intervening Sunday.

This exposition will be the first large scale attempt to display mechanical and power plant apparatus so that the present extraordinary state of development will be apparent not only to the highly trained technical man but to the layman with little knowledge of the severe problems involved in the engineering design and operation of combustion apparatus and power generating machinery. A very small percentage of the individuals in the world are informed about the tremendous importance of the enginering arts and sciences to our present civilization.

The advisory committee of the Power Exposition realizes thoroughly the need for greater public information and understanding of the engineering problems of the day and therefore it has set aside a large centrally located space at the Exposition and here will be shown models of the various devices that enter into the process of taking coal from the mine, handling it as the power plant, turning it to steam, using the steam to generate electric power and sending the current out through wires to the consumer.

As an excellent example of the manner of preparing anthracite coal for the market, the model of the famous Loree breaker of the Hudson Coal Company will be exhibited. This model, requiring an entire express car for shipment to the exposition, is a replica of the largest breaker in the world, which was erected and put in operation in 130 days and in 1921 handled 591,000,000 tons of coal. This model will show the breaker in operation, crushing the large lumps of coal, sizing it through screens and passing the sized coal through jigs where the refuse is separated out.

The development of the power station itself will be illustrated by the exhibition of a series of models of the important central stations in New York City. The original station erected by Thomas Edison in Pearl Street will appear beside the more modern Waterside Stations and the recent Hell Gate Station. The representation of this latter station is a faithful reproduction built to a scale of one-quarter of an inch to the foot. It shows the steam and electric apparatus in the plant and the various boiler room and turbine room auxiliaries as well as the elaborate machinery for handling the enormous tonnage of coal and ashes.

To further enhance the educational and informative value of the exposition each of the exhibitors will demonstrate the fundamentals underlying the operation of their apparatus by simulating actual operating conditions as nearly as possible in their exhibits. If practicable apparatus will be shown in motion, otherwise complete diagrams will be displayed.

Visitors to the Exposition will not only include members of the A. S. M. E., the A. S. R. E. and the A. S. S. E. all of whom are holding meetings during the few days preceding the meeting, but all members of engineering societies who have problems relating to power and mechanical engineering will be admitted on presentation of their membership cards. The societies who have been invited to the Exposition are: Stoker Manufacturers Assn.; American Institute of Electrical Engineers; American Economic Association; American Society Civil Engineers; American Institute of Mining and Metallurgical Engineers; Society of Industrial Engineers; Society of Welding Engineers; American Society Heating and Ventilating Engineers; National Electric Light Association; and Building Managers and Owners Association.

Realizing the great importance of the Exposition to the operating engineer, the National Association of Stationary Engineers is organizing to attend the exposition in groups. The New York Building Superintendents Association will also attend in a body, as will the Technical Publicity Association and the Blue Room Engineering Society of New York.

The Committee which is guiding the Exposition consists of Irving E. Moultrop of the Edison Electric Illuminating Company of Boston, Chairman; Dester S. Kimball, President of the American Society of Mechanical Engineers; Alexander G. Christie, Chairman Power Division A. S. M. E.; Fred Felderman, National President National Association of Stationary Engineers; Milan R. Bump, Past-President National Electric Light Association; N. A. Carle, Vice-President Public Service Production Company of New Jersey; E. B. Katte, Chief Engineer Electric Traction N. Y. C. R. R. Company; Fred R. Low, Editor "Power;" David Moffat Myers, Consulting Engineer; Calvin W. Rice, Secretary The American Society of Mechanical Engineers; and the Managers, Charles F. Roth and Fred. W. Payne, with offices in Grand Central Palace, New York.

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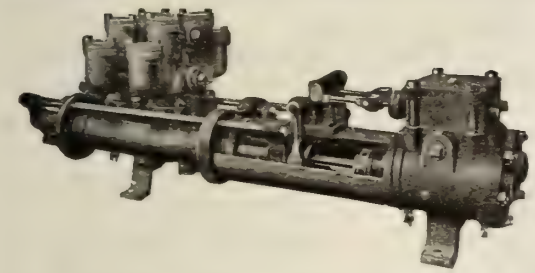

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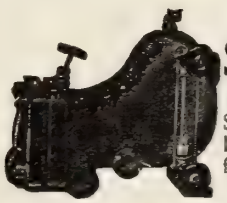

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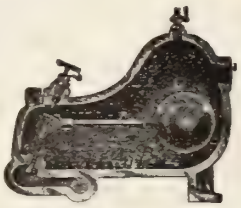

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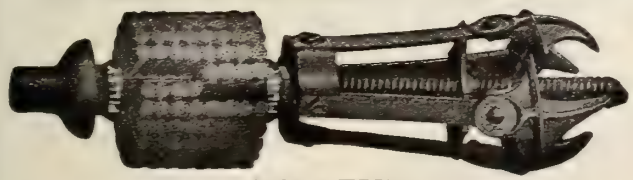

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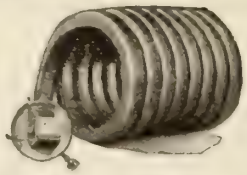

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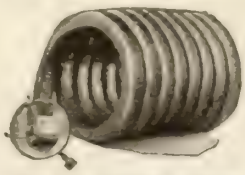

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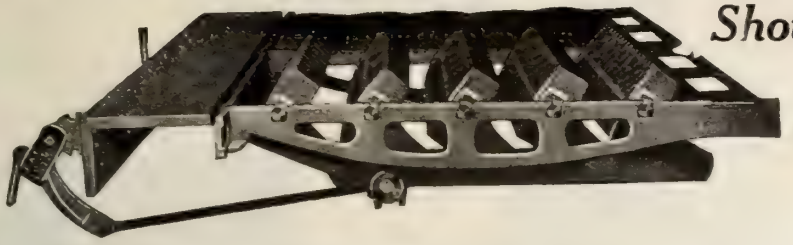

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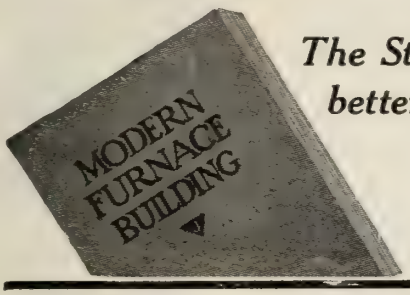

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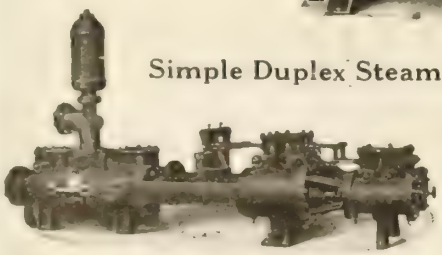

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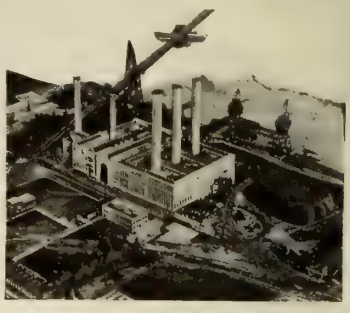

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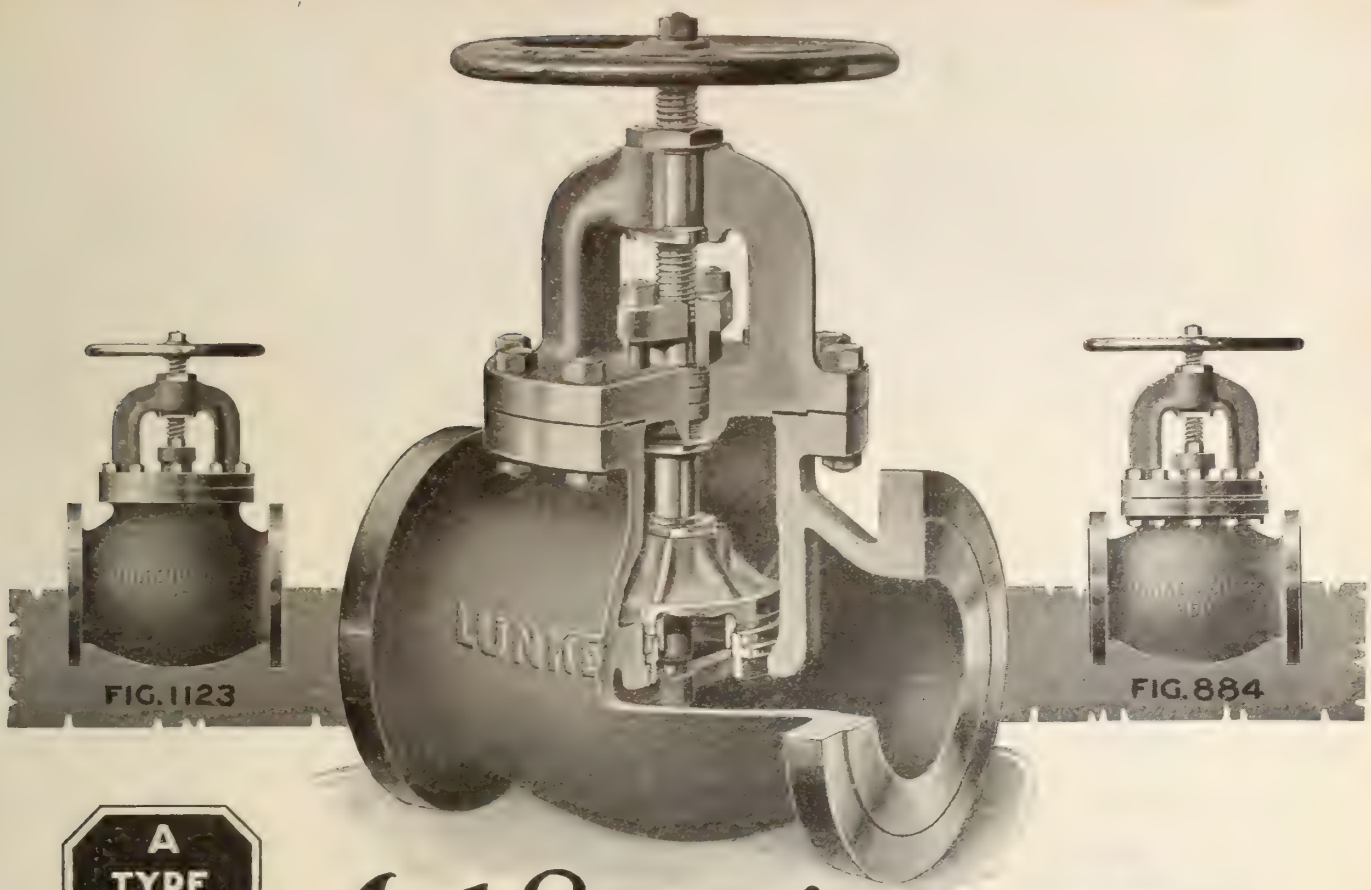

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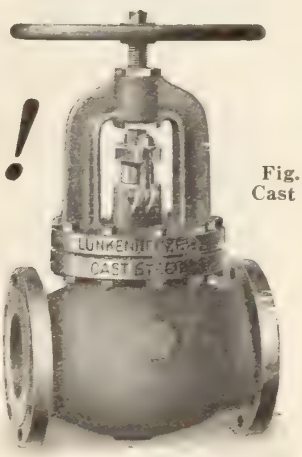

Fig. 606
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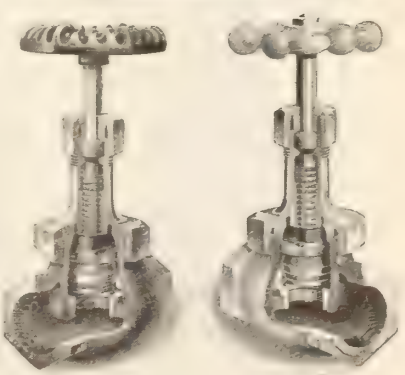

Fig. 73
"Renewo"

Fig. 1021
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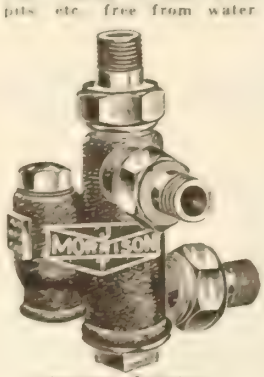

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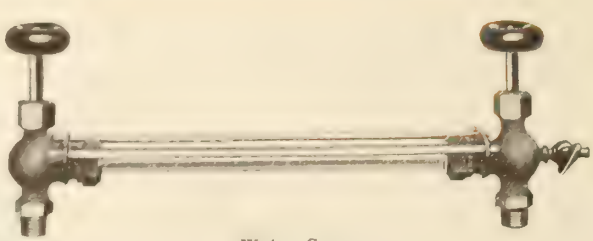

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Main & McNab Streets

Demonstrating Department:
"The Westaway Building"
Main & McNab Streets

Montreal Office:
Room 400,
McGill Building

A highly recommended Blow-off combination

"DURO"
Fig. 897, Iron Bronze Mounted for 250 lbs., W.S.P.
Fig. 1413, Cast Steel Monel Mounted, for 350 lbs., W.S.P.

"VICTOR"
Fig. 892, Iron Bronze Mounted for 250 lbs., W.S.P.
Fig. 1353, Cast Steel Monel Mounted, for 350 lbs., W.S.P.

LUNKENHEIMER
Blow-off Valves

Remain tight in service, prevent waste through boiler blow-off lines, and thereby turn to a profit the losses caused by leakage which frequently occurs at this point.

In Lunkenheimer Blow-off Valves the water is released gradually, due to the peculiar construction of the seat and disc. This virtually makes them safety devices since they eliminate the dangers incident to undue agitation within the boiler or severe shock in the discharge line which result when blow-off valves are opened suddenly.

Lunkenheimer design and construction reduces wear to a minimum. When wear does appear the repair of the parts affected is easily accomplished and when a part is worn beyond repair it can be renewed.

The installation of Lunkenheimer Blow-off Valves is the solution of your boiler blow-off problem. Why not get the facts first hand?

Descriptive literature on request.

Fig. 1352
Straightway or
Y Pattern

THE LUNKENHEIMER CO
"QUALITY"

Largest Manufacturers of
High Grade Engineering Specialties
in the World

CINCINNATI, U.S.A.

NEW YORK BOSTON
CHICAGO LONDON

Export Dept. 129-135 Lafayette St.,
New York

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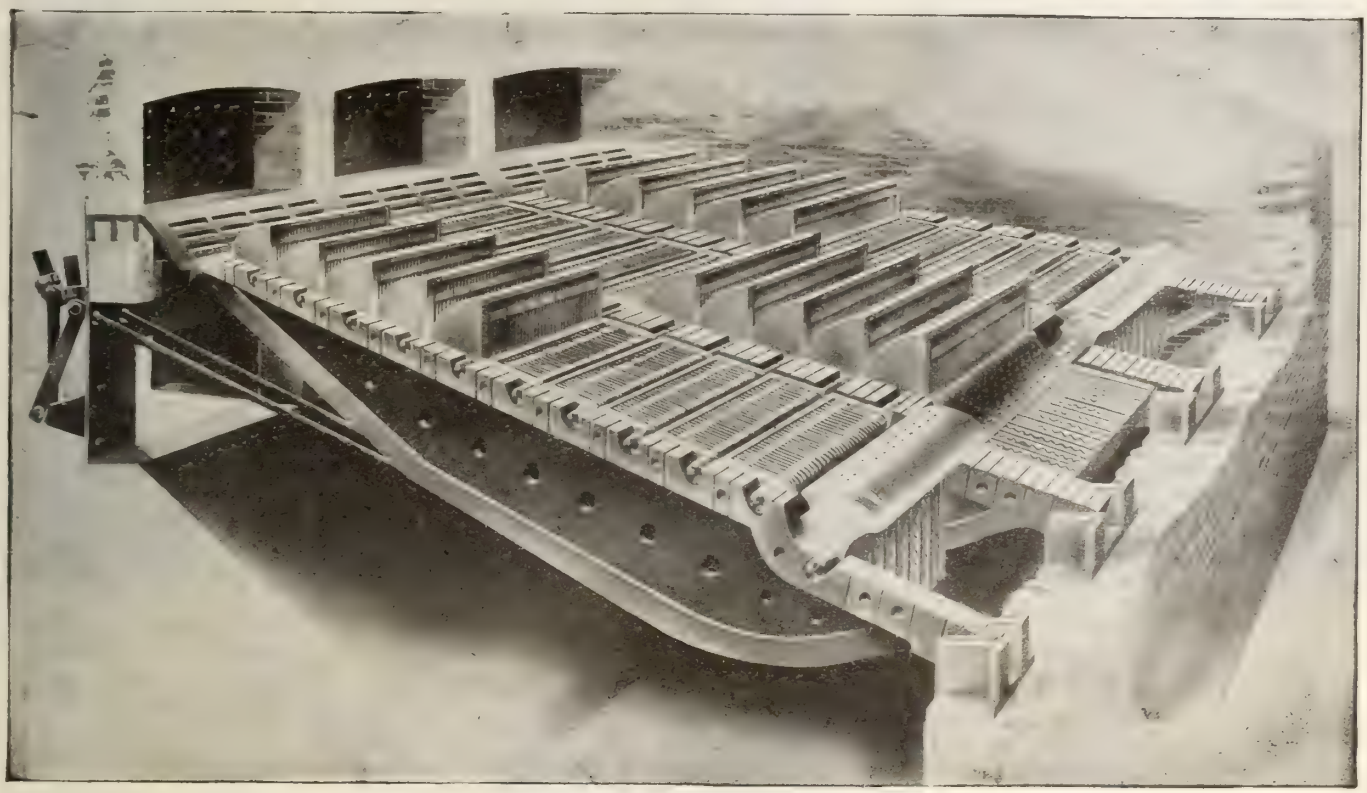
"America's Best since 1862"

Files Stokers

Hand Operated



Waterous

BRANTFORD, ONTARIO, CANADA

Electric Steam Generators,
Laurentide Company Limited

CRANE
Power Plant Equipment

Plays an important part in any well-designed power plant, and it insures a system having long life and low maintenance cost.

We can supply all the necessary valves, fittings and fabricated pipe work for any pressure or temperature that can be generated, by any pratical steam generating units.

CRANE
LIMITED
HEAD OFFICE AND SHOW ROOMS
386 BEAVER HALL SQUARE
MONTREAL

Branches and Sales
Offices in all principal cities.

Works:
1280 St. Patrick St., Montreal.

22a

They Called It A Waste of Time

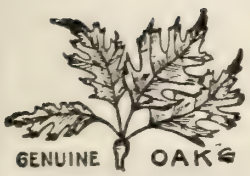
When we announced, years ago, that every inch of leather used in the making of **D. K. McLaren's Belting** would be subjected to the

Genuine British Oak Tanning Process

the statement was not taken seriously. It was thought that the process (while admittedly without an equal) would prove too expensive in application to the manufacture of belting.

Time has proved, however, that this one-time closely guarded secret process has more than justified the extra expense of tanning. It not only adds to the original toughness of the hides but it imparts a remarkable flexibility and stretchless quality that gives to **D. K. McLaren's Belting** a "gripping power" that means real "service on the pulley."

The Oak Leaf is stamped upon D. K. McLaren's Belting as a guarantee and as a guidance to engineers who have learned to appreciate trouble-free belting service.



D·K·McLAREN LIMITED

Head Office and Factory: 351 St. James St., Montreal, P.Q., Canada

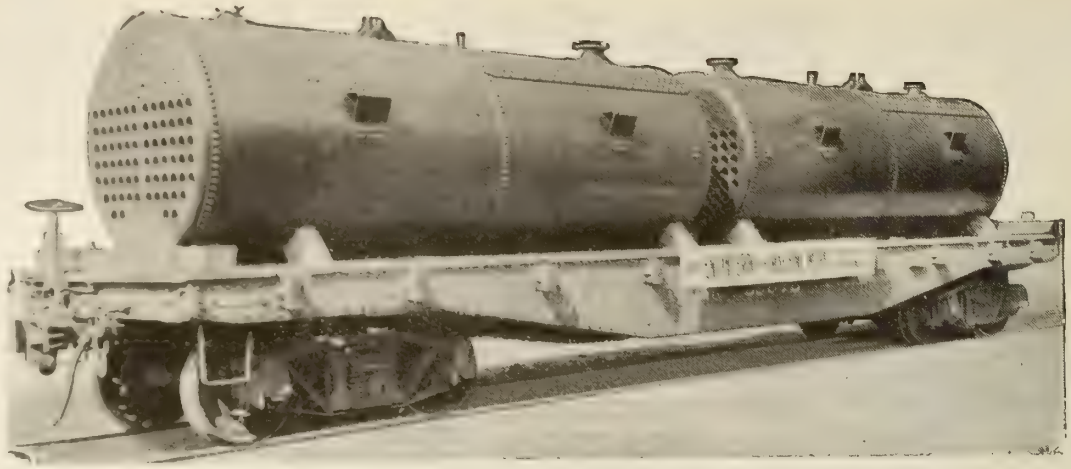
VANCOUVER, B.C.
Gormans, Limited,
1158 Homer St.

CALGARY
Gormans, Limited

EDMONTON
Gormans, Limited

TORONTO, ONT.
194 King St. West

ST. JOHN, N.B.
90 Germain St.



Boilers For 1923

Many a manufacturer could pay a dividend out of his coal pile if he went the right way about it. We mean that the very heart of his power plant—his boilers—are inefficient, out of date, always longing for the repair man—and cost far more than they should in coal expense and labor.

Our suggestion is—look into your boiler situation now. You can get from us new, modern, absolutely efficient boilers at very moderate cost, equipped with the National Hand Fired Stoker, if desired, that will be a delight to your operating staff and a very decisive factor in reducing your costs.

Engineering & Machine Works of Canada, Limited

St. Catharines, Ont.

Eastern Sales Offices : **Hall Machinery Co., Sherbrooke, Que., and Birks Bldg., Montreal**

GUTTA PERCHA & RUBBER, LIMITED
TRADE PMS MARK
THE "RED RIBBON" BELT
TORONTO, CANADA

For the Good of Your Plant Install "P M S" Belting

Your plant is the essence of your success. Whatever is good for the plant is good for your business and for you.

Exery test that we can bring to bear proves to us that "P M S" Belting is superior; in adhesion to the pulley, even pliability, strength and resistance to the effects of heat, cold and moisture. Our confidence in "P M S" Belting convinces us that it will prove good for your plant by increasing production and revenue.

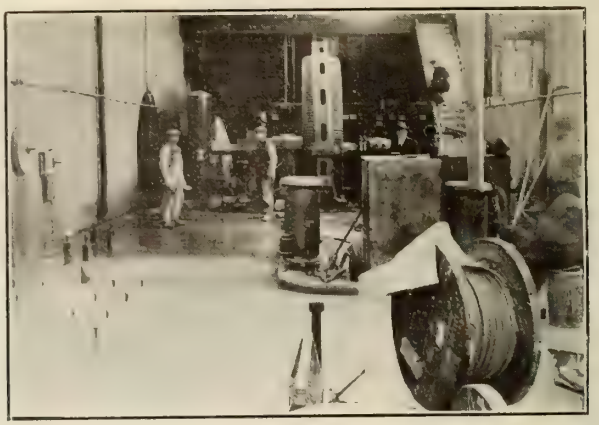
Manufactured Exclusively by

Gutta Percha & Rubber, Limited

Head Offices and Factories: Toronto, Canada

Branches in All Leading Canadian Cities

Inside of Forebay—upstream face of Breast Wall—for 1600 h.p. unit.



Interior of Power House, showing Breast Wall.

The left wall of the Power House interior is the inside of the Breast Wall which shows in the illustration on the left.

THE NASSAU POWER PLANT

of the

Canadian General Electric Company

At PETERBOROUGH, ONTARIO

This plant was constructed in connection with the reconstruction of the Nassau Dam by the Department of Railways and Canals. The first unit of the plant was put into operation in March, 1922.

The entire sub-structure of the Power House, including the forebay walls and draft tubes, is of concrete. It being essential that hydraulic losses should be reduced to a minimum, the draft tubes were finished with very smooth surfaces and well rounded corners.

The up-stream wall of the Power House is also the breast wall, and the interior of this wall is "bone dry," notwithstanding the pressure of the full head of 18 feet of water on the up-stream side. This result was obtained without the use of any waterproofing materials, which furnishes evidence of the value of concrete construction wherever a waterproof structure is required.

The Power House sub-structure was carried out in conjunction with the reconstruction of the Nassau Dam by the engineers of the Department of Railways and Canals, to the designs of Walter J. Francis and Company, the Consulting Engineers for the Canadian General Electric Company.

Canada Cement Company Limited

Canada Cement Company Building
Phillips Square MONTREAL

Sales Offices at : MONTREAL TORONTO WINNIPEG CALGARY

SPECIFY
CANADA CEMENT
Uniformly Reliable

CANADA CEMENT
CONCRETE
FOR PERMANENCE

We maintain a Service Department to co-operate in all lines of work for which concrete is adapted. Our library is comprehensive and is at your disposal at all times without charge.

Coal is the least that a leaky steam trap wastes

By the time power gets up to your coils or machines as steam, it costs far more than at the coal pile, heat unit for heat unit. All along the line you are adding charges of firing, oiling, superintendence and overhead.

So to measure the loss from a leaky steam trap in tons of coal or units of power is not enough. This is a fact which drives home the importance of a steam trap worthy of the name.

"Just a ball—that's all!" A floating ball is the only moving part of the Johns-Manville Steam Trap. No valves, levers or thermostats to get out of order. And the action of this Trap, in preventing loss of steam and discharging air and water, is as sure as it is simple.

Why Johns-Manville Steam Traps do not leak

There is always, in a Johns-Manville Trap, a thin water seal between the steam and the outlet. Here is how this Trap works—and the extreme simplicity of its construction means that it always *does* work.

A hollow ball is the only moving part.

When the entering water raises the ball, the discharge orifice is exposed, and water and air flow out.

When the water level drops, the ball drops. It rolls over the discharge orifice, thus throttling down the outflow and maintaining sufficient water in the Trap to prevent steam leakage.

This action is sure. You can depend on the Johns-Manville Steam Trap to save power and so to help cut your operating costs.

CANADIAN JOHNS-MANVILLE CO., LIMITED
Toronto Montreal Winnipeg Vancouver Windsor Ottawa

JOHNS-MANVILLE SERVICE
COVERS THE CONTINENT

Through—

Asbestos
and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak-proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Power Plant Materials

High Grade Regrinding Valves

"RELIANCE"

and

"STERLING"

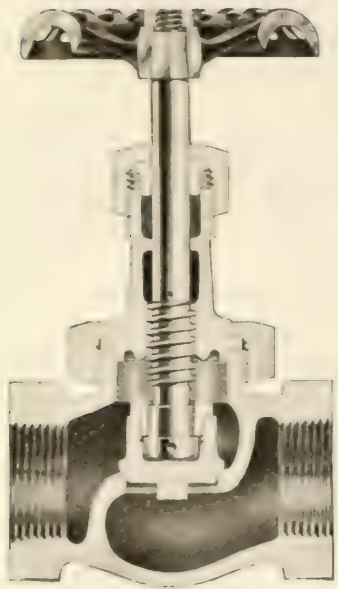


Fig. 425.
"RELIANCE"
Regrinding Bronze Globe Valve
(Sectional View).

The perfection made possible by years of experience in the manufacture of high grade Valves and Boiler Mountings is embodied in these Regrinding Valves.

They are made by Jenkins Bros. —a fact that guarantees them not only as regards materials but as regards Service and Dependability.

Each separate part of "RELIANCE" and "STERLING" Regrinding Valves is carefully inspected before it leaves the Foundries, is again inspected during process of manufacture and, when finally assembled, the Valves are subjected to a most rigid service test.

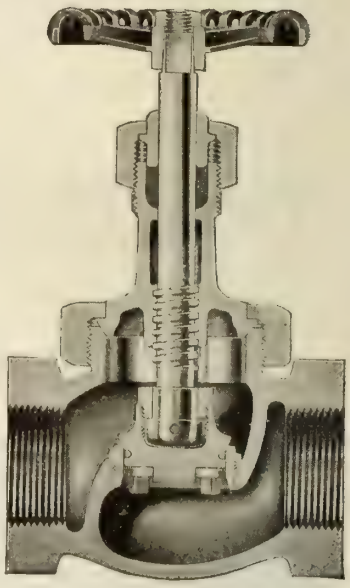
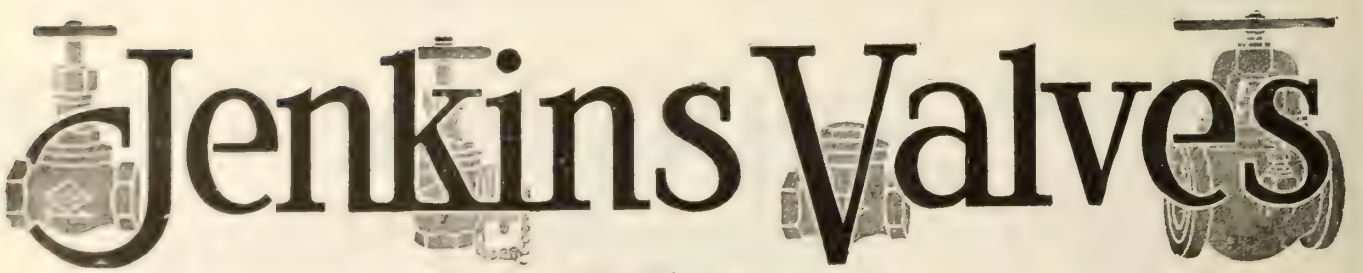


Fig. 500.
"STERLING"
Regrinding Bronze Globe Valve
(Sectional View).

These Valves have already proven their dependability in various parts of the world. May we send you descriptive illustrated literature?

JENKINS BROS. LIMITED
103 ST. REMI ST., MONTREAL
TORONTO VANCOUVER
European Branch:
6 Great Queen St., Kingsway, London, W. C. 2, Eng.



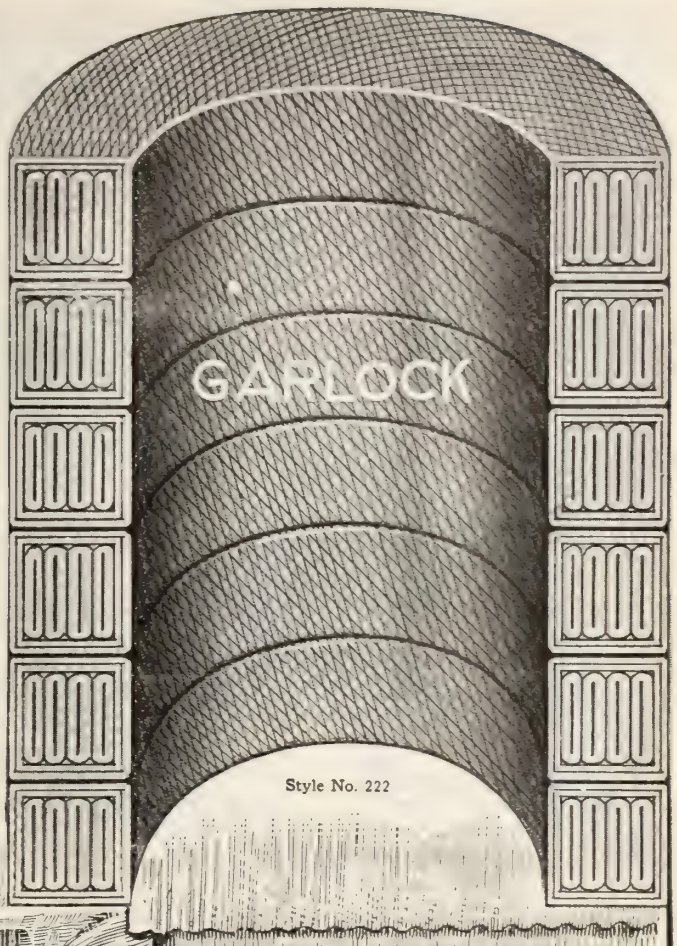
SINCE 1864

On Great Engineering Projects

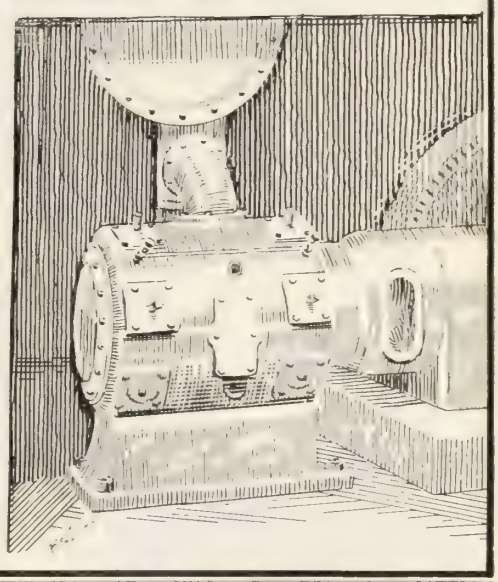
Following the hose and pipe lines from clanking rock drills, back perhaps to a shanty open to dust and dirt, we come to the throbbing air compressor.

The compressor rod packing forms an important item contributing toward successful and continuous operation. The intense dry heat of compression together with the abrasive action of grit and dust soon destroy a packing not designed for this trying service.

Garlock Style No 222 combination packing, designed with a thorough understanding of compressor requirements, has given efficient and continuous service on compressor rods under all conditions.



Style No. 222



"SPARE THE ROD"

GARLOCK PACKINGS

THE GARLOCK PACKING COMPANY,
HAMILTON, ONTARIO

BRANCHES:

Montreal, Que. Toronto, Ont. Winnipeg, Man.
Calgary, Alta. St. John, N.B. Vancouver, B.C.

LINDE

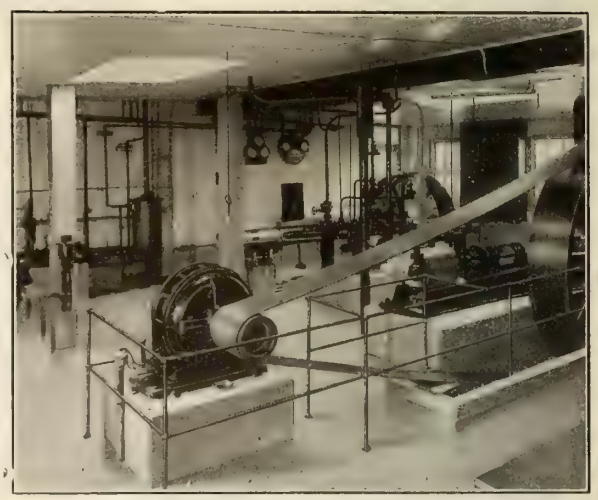
Made in Canada

REFRIGERATING AND ICE MAKING MACHINERY

For Refrigerating and Ice Plants, Large and Small.

Mechanical refrigeration scientifically applied yields increased returns to the user.

Linde Refrigerating and Ice Making Machinery offer every improvement and convenience. Our new vertical enclosed type machines are designed for plants from 1 to 30 tons. Then for demands calling for loads up to 300 tons, our horizontal frame type is guaranteed to give better service than any other equipment on the market.



This 100-ton plant was designed by our engineers. These men are at your service. Designs, specifications and estimates upon request.

The Linde Canadian Refrigeration Co., Ltd.

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

Jamison HEAVY DUTY

Cold Storage Doors

Scientifically Built

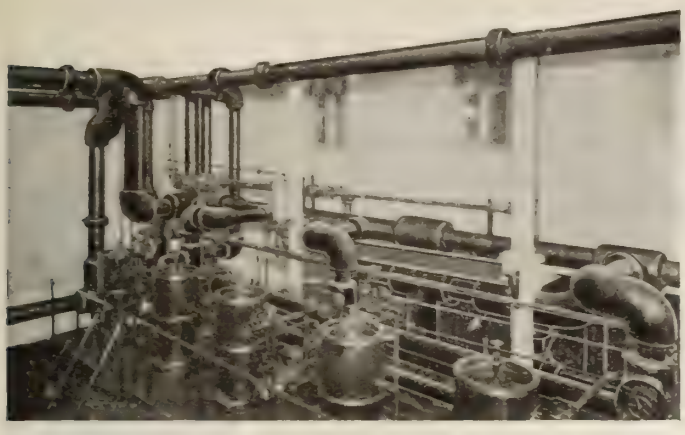
The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.

(Formerly Jones Cold Store Co.)

HAGERSTOWN MARYLAND, U.S.A.



Nonpareil Cork Covering on the ammonia lines and headers of the Abbott Ice Cream Company, Philadelphia, Pa.

COVERED

AND covered right. Every foot of pipe, every ell and tee and valve and union is so thoroughly protected by Nonpareil Covering that not a bit of frost shows anywhere. This is an excellent illustration of the *right* way to insulate brine and ammonia lines:

First—Insulate with Nonpareil Cork Covering because it is unquestionably the most efficient, durable and economical insulation made for cold lines; and

Second—Cover every square inch that needs insulation. Frost will form on exposed surfaces and damage your covering by working back under it.

Nonpareil Cork Covering saves 80% of refrigeration losses from uninsulated lines. 80% —that will pay the entire cost of the covering in less than a year, and there are records of Nonpareil Covering in service 20 years after it was installed.

The reason, of course, is that Nonpareil Cork Covering is moisture-proof and frost-proof. Properly applied and given reasonable care, it will not deteriorate. Actually, Nonpareil Cork Covering "Lasts Longer Than the Pipe."

Detailed information, samples and prices, will be furnished on request.

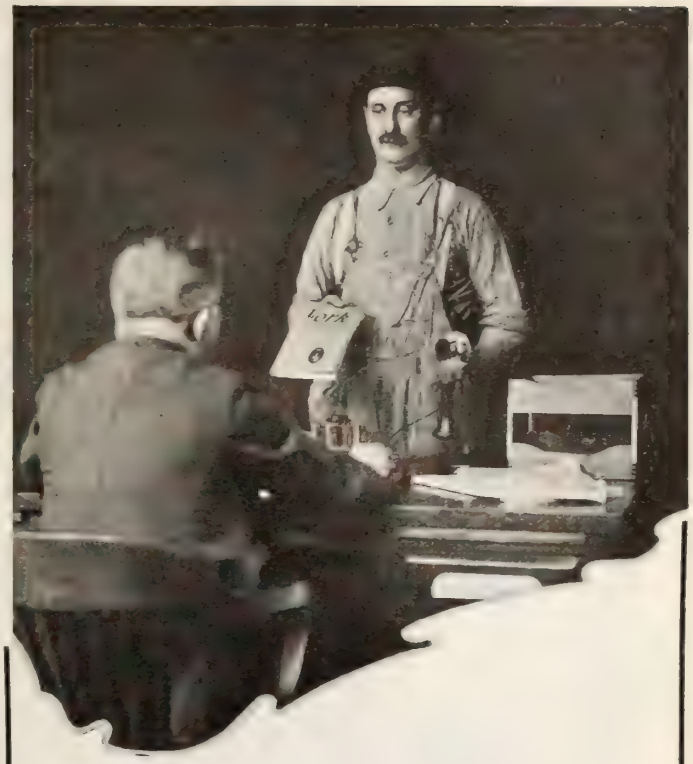
Armstrong Cork & Insulation Co., Ltd.

902 McGill Building, Montreal, Quebec
11 Brant Street, Toronto, Ontario

Also manufacturers of Nonpareil Corkboard Insulation for cold storage and constant temperature rooms and for settling tanks; Nonpareil High Pressure Covering for steam lines, feed water heaters, boilers, etc.; Nonpareil Insulating Brick for boiler settings, furnaces, ovens, etc.; Nonpareil Machinery Isolation for noisy machines, and Linotile and Armstrong's Cork Tile for floors in offices, residences, etc.

Nonpareil Cork Covering

For All Cold Lines



'For Reliable Service give me YORK Equipment"

When the Operating Engineer of an Ice Making or Refrigerating Plant insists upon the Plant Manager buying York Ammonia Fittings and Supplies, he knows he is saving himself a lot of time and trouble and also reducing the operating costs of the plant.

He knows, because he has learned through past experiences of his own, or perhaps from another Engineer, that York Equipment is designed and made to meet the severest Service.

Surely, the man who is responsible for the operation of the plant, who sees and handles the equipment every day, should be best able to judge the merits of each piece of apparatus.

And the engineer out of justice to his employers and to himself, will recommend York Apparatus, which he realizes will give satisfactory results in actual service. That's why more York Ammonia Fittings and Supplies are sold each year than any other make.

There is perhaps no other concern of its kind in the world able to handle such a large number of orders or such a heavy volume of business.

A trial order will convince you of the Superior Quality of York Ammonia Fittings and Supplies.

CANADIAN ICE MACHINE CO., LTD.

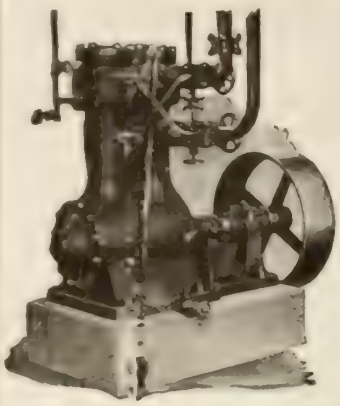
Toronto: Villiers and Munition Sts., Eastern Harbor Terminals
Montreal: 24 Craig St. West Winnipeg: 1415 Waverley Ave.
Vancouver: 1158 Homer St.

Representing

YORK MANUFACTURING CO.

Ice Making and Refrigerating Machinery Exclusively

YORK PENNA., U.S.A.



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

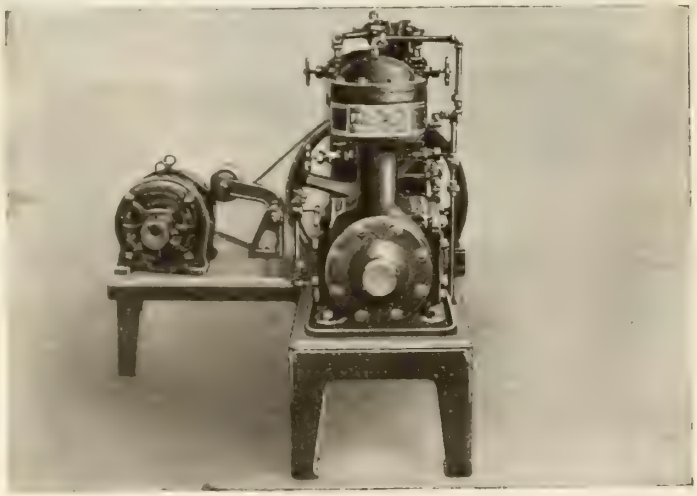
Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones.
AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada

CORLISS and POPPET VALVE ENGINES

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



FRICK Combined Refrigerating Machine

This machine fills the needs of dairies, groceries, meat markets, restaurants, hospitals, confectionery and floral shops, etc., for a simple and efficient small refrigerating plant.

The machine is manufactured in one-ton and two-ton sizes. It is a complete self-contained unit, including compressor, condenser, separator, receiver and connections mounted on one solid portable iron base as shown. It is completely assembled in one crate with motor and motor base in separate box, and can be taken through a 26-inch door without uncrating.

No foundation is required. The machine is as easily put in place as the ordinary counter or refrigerator, and as easily removed—an important feature to the user who rents his place of business.

Machine is completely protected with safety devices. Either part automatic or full automatic control is supplied as desired. It is unusually quiet in operation and can be placed in any desirable location.

Ask our nearest distributor for further details and prices.

Ask for a copy of our List of Users covering 48 pages of satisfied customers—also your copy of Ice and Frost.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

BRANCHES IN ALL PRINCIPAL CITIES

There is a FRICK Machine for every refrigerating purpose—all types: Vertical—Horizontal—Absorption.

Canadian Representative: FRICK Ice and Refrigeration Co., Montreal

NORTHERN CRANES
NORTHERN CRANE WORKS, LTD

INVESTIGATE THE

ADVERTISEMENTS

APPEARING IN EVERY ISSUE

OF POWER HOUSE

MONCRIEFF'S

Moncrieff's "Unific" is not a cheap [illegible] but because it contains many ordinary pieces the "Unific" is economical. British Made.

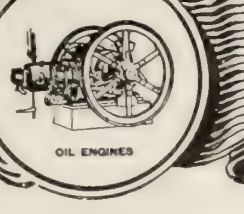
"UNIFIC" WATER GAUGE

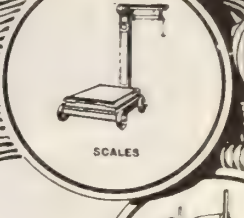
JOHN MONCRIEFF LIMITED
PERTH, SCOTLAND

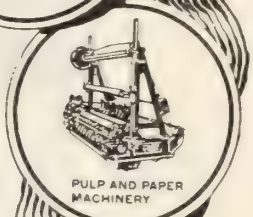
GLASSES

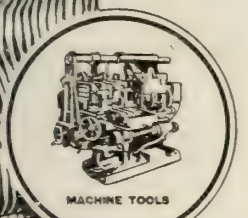
The "Unific" does not readily corrode. It resists extreme changes of temperature and withstands the highest working steam pressure.

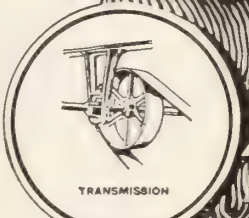
Canadian Representative: W. J. WALL, 134-136 Bleury St., MONTREAL, CANADA

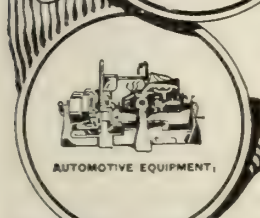


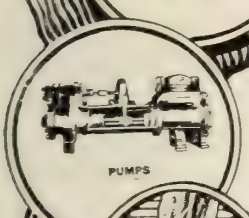












Representing the Leading Manufacturers

In addition to manufacturing and distributing Fairbanks-Morse products, The Canadian Fairbanks-Morse Co., Limited, represents the leading manufacturers of mechanical goods.

When ordering from our nearest branch, you are ordering from the manufacturer whose product has proved itself the acknowledged leader in its particular field. Here are some of the well known lines we handle:—

Fairbanks Scales
Pratt & Cady Valves
Palmetto Packing
Strong Steam Traps
Allen Engines
Landis Threaders
Graton & Knight Leather Belting
Yale Chain Hoists
Gould's Pumps
Fairbanks Valves
Durabla Packing
Foster Regulators
Fairbanks-Morse Gas and Oil Engines
South Bend Lathes
Dick's Balata Belting
Norton Grinding Wheels
Fairbanks-Morse Generators
Fairbanks-Morse Pumps

Each department is in charge of men who can give you valuable help in the solution of your problems.

Canada's Departmental House for Mechanical Goods

The CANADIAN FAIRBANKS-MORSE CO LIMITED

St. John Quebec Montreal Ottawa Toronto
Hamilton Windsor Winnipeg Regina
Saskatoon Calgary Vancouver Victoria

Cut Out One Boiler IN THREE

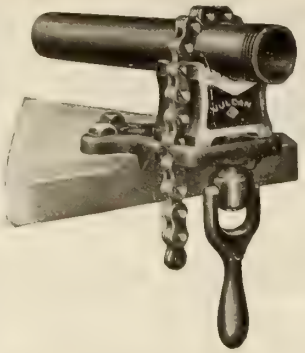
One factory, by correctly handling condensation with Cole traps, enabled the engineer to cut out one boiler from a battery of three and using 25 per cent. less coal than before; yet providing more steam than the factory required though turning out greater production than before.

What we did for this factory we can do for you. If you are interested in reducing your cost of power, write us for particulars of the Cole Trap System in this plant.

Prompt Shipments

GRANT E. COLE Co.

21 River Street, TORONTO



Williams' "Vulcan" Chain Pipe Vise

UNBREAKABLE, compact, rapid in action and positive in gripping pipe. Attachable **anywhere**—any handy bench, post or other support will serve.

Made entirely of wrought steel; the drop-forged jaws are saw-tempered for file sharpening and the hand-made chains are of the same superior quality as those of our well-known "Vulcan" Chain Pipe Wrenches.

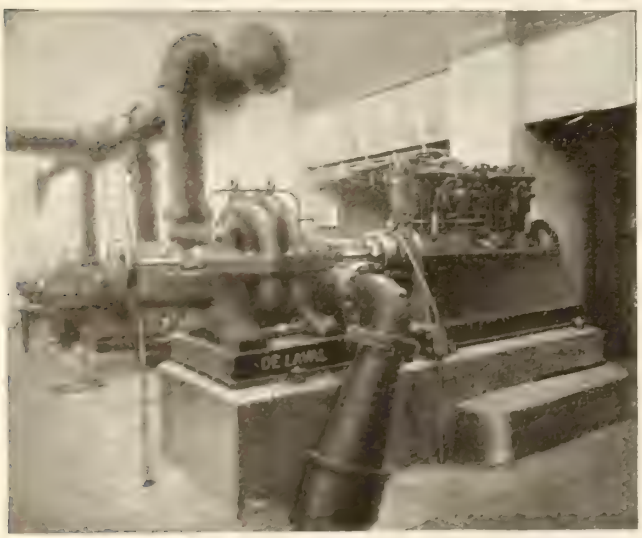
Vises in 3 sizes for ⅛ to 8-inch pipe. Booklet on request.

J. H. WILLIAMS & CO., Limited

"The Drop-Forging People"

78 Thorold Road - St. Catharines, Ont.

ORILLIA, ONT., SELECTS DE LAVAL PUMPS FOR SAFETY AND ECONOMY



THREE DE LAVAL centrifugal pumps installed in the water works pumping station of the City of Orillia, Ont., are shown herewith. The two-stage 8-in. pump in the foreground is driven by a gasoline engine, and has a capacity of 1,440 gal. per min. against 325 ft. head. The two De Laval pumps in the background are driven by electric motors. Where cheap electric power is available, this type of plant combines low cost, simplicity, and insurance against shut-down. The amount of attention required is very small, and practically no supplies are used.

The De Laval centrifugal pump is ideally adapted for both electric motor and gasoline engine drive. The starting torque is low and the power characteristic permits the size of motor to be selected to suit the normal capacity, resulting in lower power factor and higher efficiency in the driving motor. In many instances De Laval pumps are driven by self-starting synchronous motors,-which can be used to correct the power factor.

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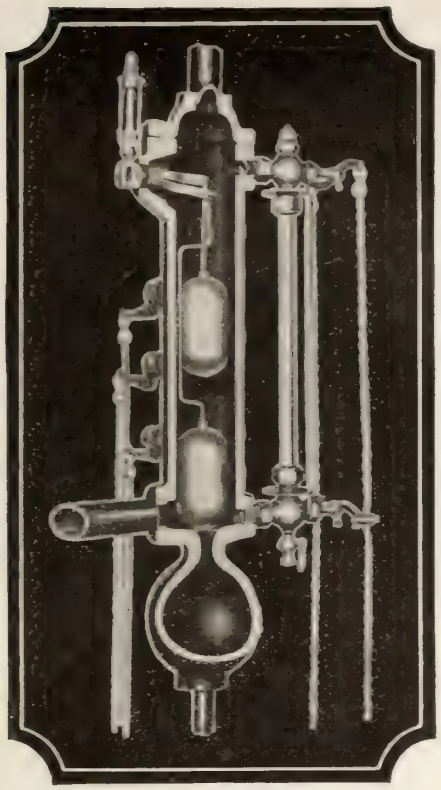

The working parts of a Reliance Column, shown here, are proofed against all kinds of wear or deterioration

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Loss, confusion and inconvenience are not the only unhappy results that follow when your fireman pulls his fires and the wheels stop turning.

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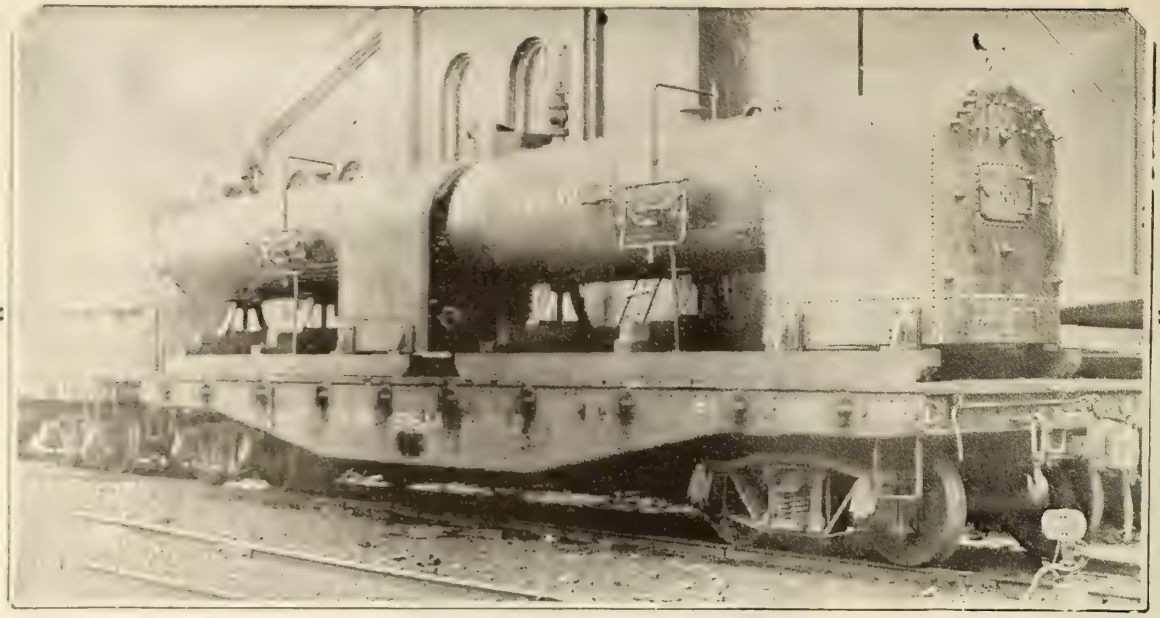

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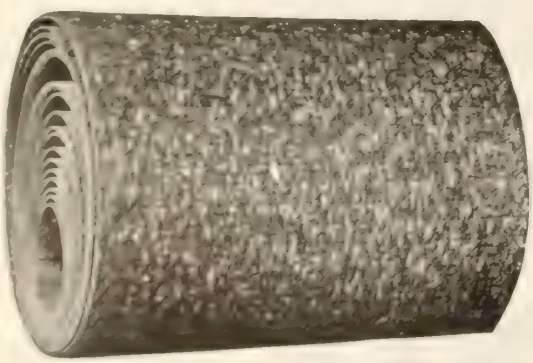

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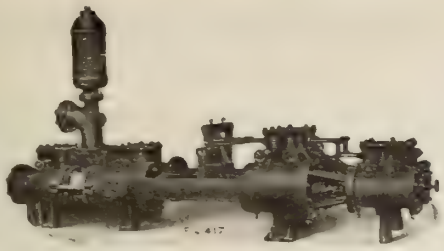

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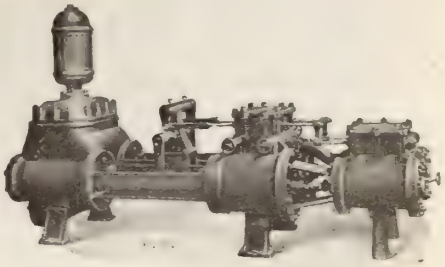

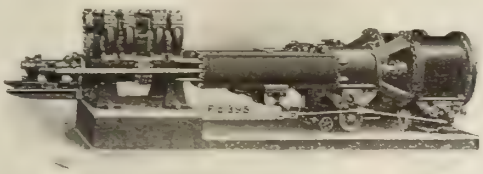

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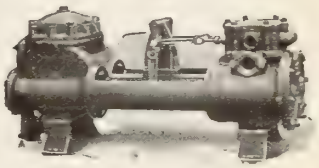

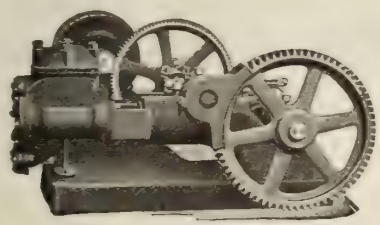

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Steam
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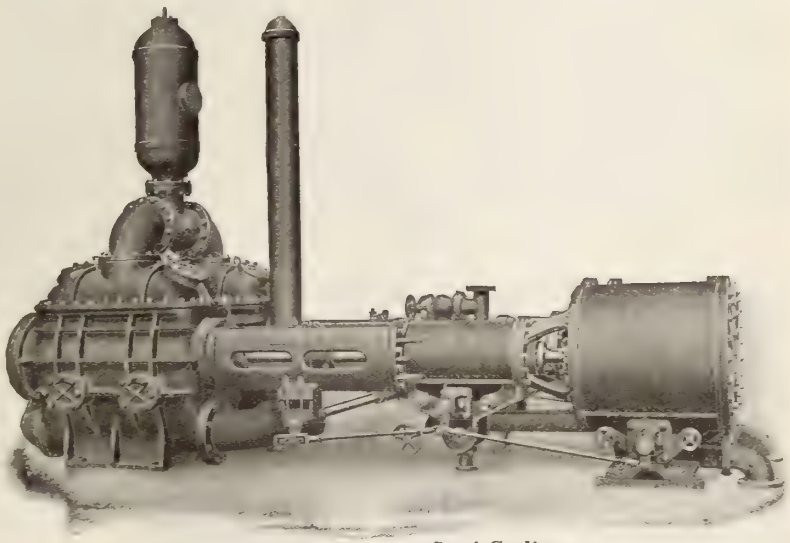
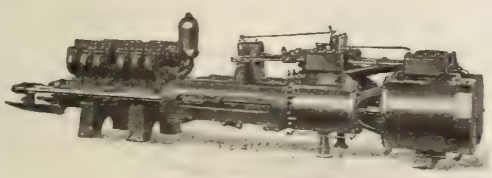


Semi-Corliss
Piston Valve



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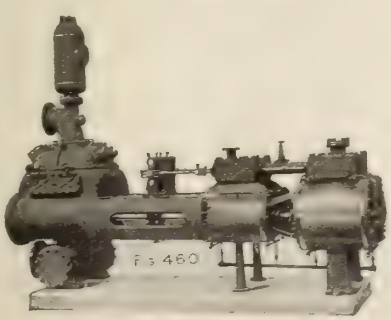
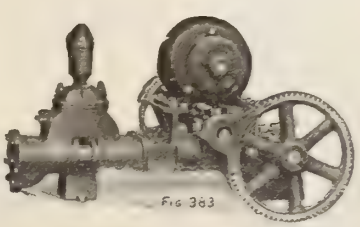
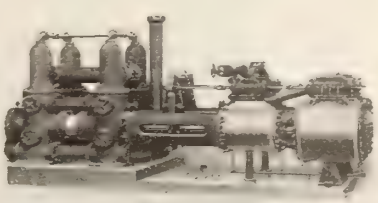
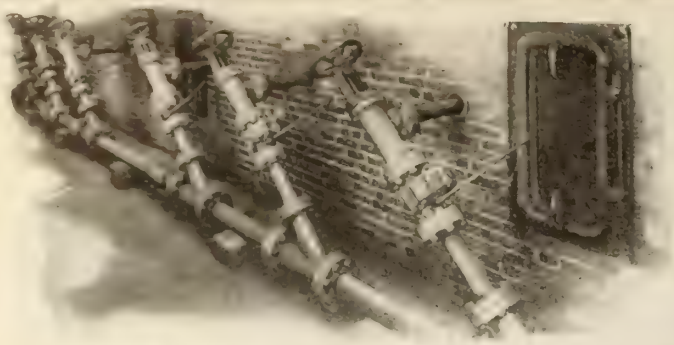
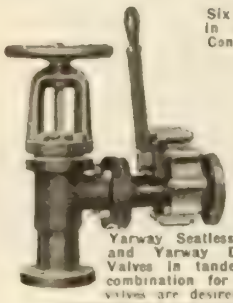








Six of the twenty-one Yarway Seatless Blow-Off Valves in service at the United Illuminating Co., Bridgeport, Conn.



Yarway Seatless Blow-Off Valve (formerly the Simplex). Send for celluloid model illustrating operation of this unique valve.

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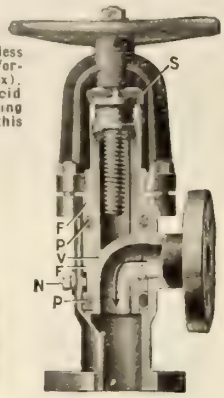

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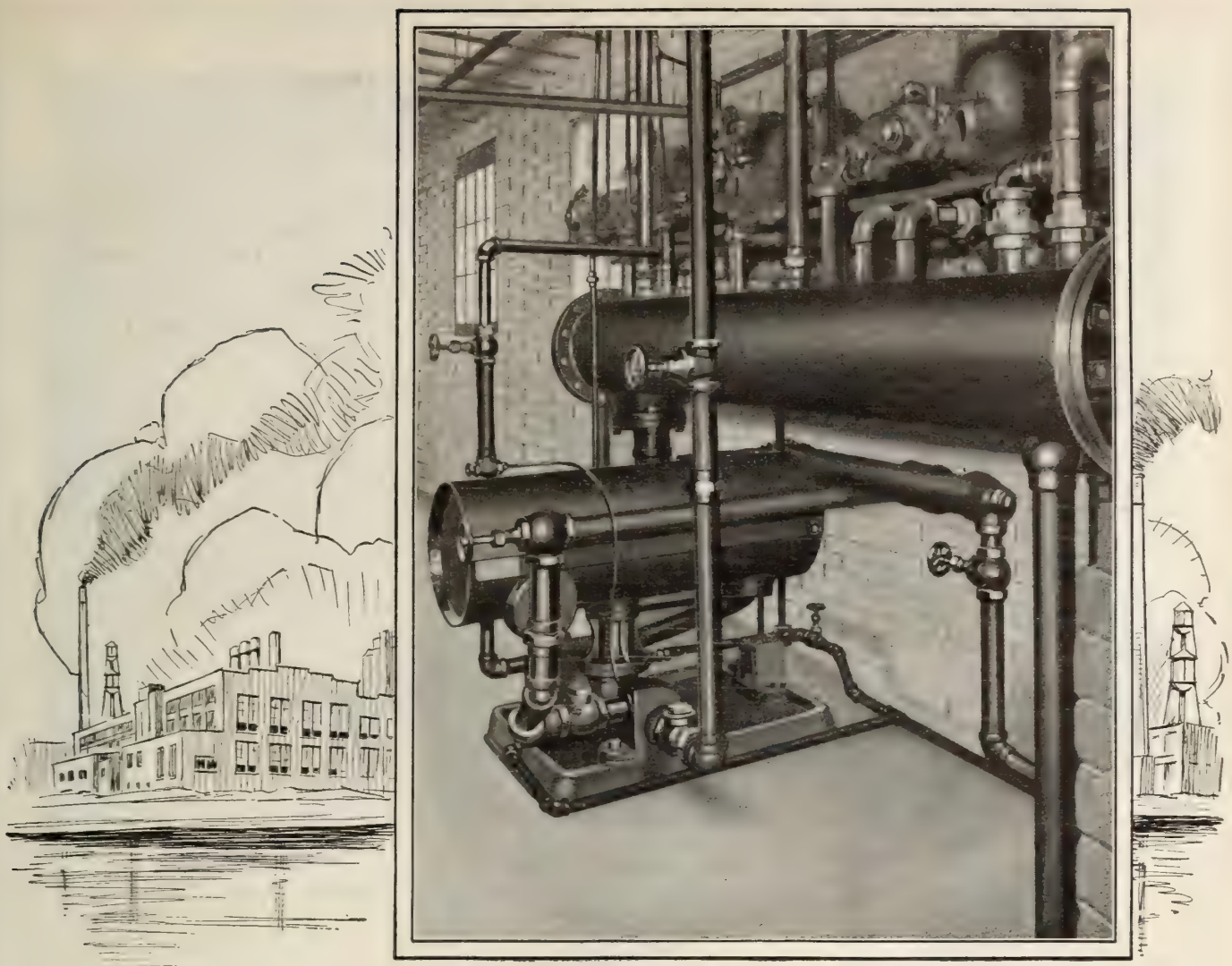

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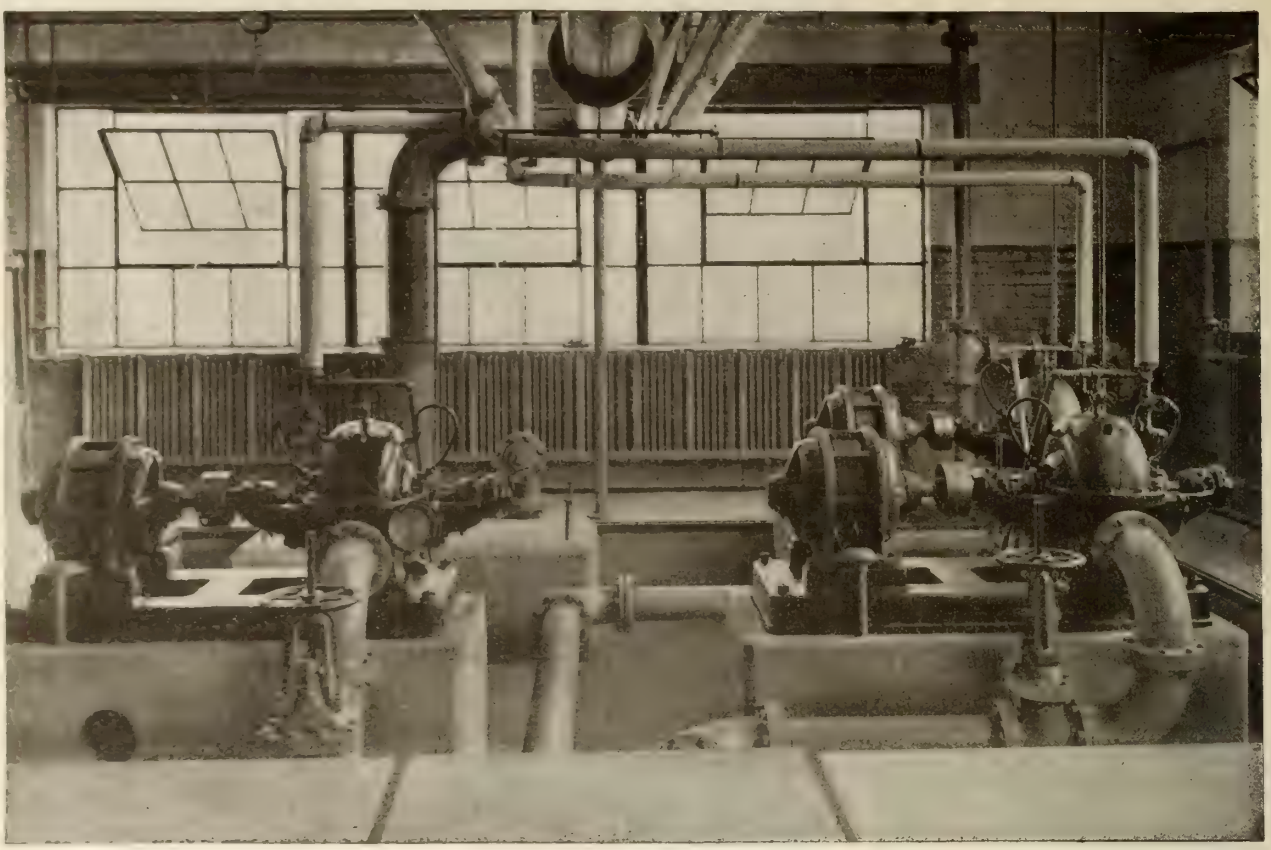

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Established 1907
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Method of Reading Steam Tables Correctly

An Explanation of What Each Column in the Steam Table Really Means, and Some Examples of the Method of Application to Every Day Problems

By T. H. FENNER, A.M.E.I.C.

THERE seems to be a doubt in the minds of many engineers when making calculations of the heat in steam, and water, of the proper method of handling the steam tables. We are driven to this conclusion by the result of questions put in the form of an examination to a number of candidates for the graded certificates, and it seems that perhaps a little explanation of this matter might be timely. It would seem at first glance as though there were but little chance of making any mistake, when the tables are so complete, but we have conclusive evidence that mistakes are made. It is our purpose then to examine the steam table in detail, and show how it should be used to obtain correct results in a number of different instances.

Properties of Steam

The particulars given in the steam tables are those of the properties of steam, that is the physical characteristics of the vapor formed when water is heated to certain temperatures. Leaving out the two last columns which deal with the entropy of water and of evaporation, which are quantities involving too much explanation to be treated here, the characteristics treated are eight in number. The table shown here is that of Marks and Davis, and is the accepted standard at the present date. Other tables are in use which differ slightly from this one, but the differences are chiefly in the latent heat at different pressures and temperatures, and are but slight. The table used by the Board of Examiners is somewhat older than this one, but as long as the work is done according to the table at hand the result will be correct for all practical purposes. In questions involving design, of course, the latest available table would be used.

First and governing all the other conditions, is the absolute pressure of the steam. This needs no explanation to the average engineer, it being the pressure measured from absolute vacuum, and is equal to gauge pressure plus 14.7 lbs.

Abs. pres., lb., p	Temp., deg. fahr., t	Sp. vol., cu. ft. per lb., v''	Density, lb. per cu. ft., $1/v''$	Heat of the liquid, i'	Latent heat of evap., r	Heat content of steam, i''	Internal energy (B.t.u.) evap., l	Entropy	
								Water, s'	Evap., r/T
1	101.83	333.0	0.00300	69.8	1034.6	1104.4	972.9	0.1327	1.8427
2	126.15	173.5	0.00576	94.0	1021.0	1115.0	956.7	0.1749	1.7431
3	141.52	118.5	0.00845	109.4	1012.3	1121.6	946.4	0.2008	1.6840
4	153.01	90.5	0.01107	120.9	1005.7	1126.5	938.6	0.2198	1.6416
5	162.28	73.33	0.01364	130.1	1000.3	1130.5	932.4	0.2348	1.6084
6	170.06	61.89	0.01616	137.9	995.8	1133.7	927.0	0.2471	1.5814
7	176.85	53.56	0.01867	144.7	991.8	1136.5	922.4	0.2579	1.5582
8	182.86	47.27	0.02115	150.8	988.2	1139.0	918.2	0.2673	1.5380
9	188.27	42.36	0.02361	156.2	985.0	1141.1	914.4	0.2756	1.5202
10	193.22	38.38	0.02606	161.1	982.0	1143.1	910.9	0.2832	1.5042
11	197.75	35.10	0.02849	165.7	979.2	1144.9	907.8	0.2902	1.4895
12	201.96	32.36	0.03090	169.9	976.6	1146.5	904.8	0.2967	1.4760
13	205.87	30.03	0.03330	173.8	974.2	1148.0	902.0	0.3025	1.4639
14	209.55	28.02	0.03569	177.5	971.9	1149.4	899.3	0.3081	1.4523
14.7	212.00	26.79	0.03732	180.0	970.4	1150.4	897.6	0.3118	1.4447
15	213.0	26.27	0.03806	181.0	969.7	1150.7	896.8	0.3133	1.4416
16	216.3	24.79	0.04042	184.4	967.6	1152.0	894.4	0.3183	1.4311
17	219.4	23.38	0.04277	187.5	965.6	1153.1	892.1	0.3229	1.4215
18	222.4	22.16	0.04512	190.5	963.7	1154.2	889.9	0.3273	1.4127
19	225.2	21.07	0.04746	193.4	961.8	1155.2	887.8	0.3315	1.4045
20	228.0	20.08	0.04980	196.1	960.0	1156.2	885.8	0.3355	1.3965
21	230.6	19.18	0.05213	198.8	958.3	1157.1	883.9	0.3393	1.3887
22	233.1	18.37	0.05445	201.3	956.7	1158.0	882.0	0.3430	1.3811
23	235.5	17.62	0.05676	203.8	955.1	1158.8	880.2	0.3465	1.3739
24	237.8	16.93	0.05907	206.1	953.5	1159.6	878.5	0.3499	1.3670
25	240.1	16.30	0.0614	208.4	952.0	1160.4	876.8	0.3532	1.3604
26	242.2	15.72	0.0636	210.6	950.6	1161.2	875.1	0.3564	1.3542
27	244.4	15.18	0.0659	212.7	949.2	1161.9	873.5	0.3594	1.3483
28	246.4	14.67	0.0682	214.8	947.8	1162.6	872.0	0.3623	1.3425
29	248.4	14.19	0.0705	216.8	946.4	1163.2	870.5	0.3652	1.3367
30	250.3	13.74	0.0728	218.8	945.1	1163.9	869.0	0.3680	1.3311
31	252.2	13.32	0.0751	220.7	943.8	1164.5	867.6	0.3707	1.3257
32	254.1	12.93	0.0773	222.6	942.5	1165.1	866.2	0.3733	1.3205
33	255.8	12.57	0.0795	224.4	941.3	1165.7	864.8	0.3759	1.3155
34	257.6	12.22	0.0818	226.2	940.1	1166.3	863.4	0.3784	1.3107
35	259.3	11.89	0.0841	227.9	938.9	1166.8	862.1	0.3808	1.3060
36	261.0	11.58	0.0863	229.6	937.7	1167.3	860.8	0.3832	1.3014
37	262.6	11.29	0.0886	231.3	936.6	1167.8	859.5	0.3855	1.2969
38	264.2	11.01	0.0908	232.9	935.5	1168.4	858.3	0.3877	1.2925
39	265.8	10.74	0.0931	234.5	934.4	1168.9	857.1	0.3899	1.2882
40	267.3	10.49	0.0953	236.1	933.3	1169.4	855.9	0.3920	1.2841
41	268.7	10.25	0.0976	237.6	932.2	1169.8	854.7	0.3941	1.2800
42	270.2	10.02	0.0998	239.1	931.2	1170.3	853.6	0.3962	1.2759
43	271.7	9.80	0.1020	240.5	930.2	1170.7	852.4	0.3982	1.2720
44	273.1	9.59	0.1043	242.0	929.2	1171.2	851.3	0.4002	1.2681
45	274.5	9.39	0.1065	243.4	928.2	1171.6	850.3	0.4021	1.2644
46	275.8	9.20	0.1087	244.8	927.2	1172.0	849.2	0.4040	1.2607
47	277.2	9.02	0.1109	246.1	926.3	1172.4	848.1	0.4059	1.2571
48	278.5	8.84	0.1131	247.5	925.3	1172.8	847.1	0.4077	1.2536
49	279.8	8.67	0.1153	248.8	924.4	1173.2	846.1	0.4095	1.2502

The next column gives the temperature Fahrenheit of the steam at the pressure contained in the first column, and this temperature is, of course, measured from zero Fahrenheit. We will point out something in connection with this column a little later when we come to the column under the heading heat of liquid. The third column gives the volume in cubic feet of one pound of steam

at the pressure in the first column, and this is called the specific volume of the steam. This column and the column next to it are definitely related, the fourth column being the "Density" or weight of steam at the pressure in the first column. Now if one cubic foot of steam at 1 lb. per square inch absolute pressure occupies 333 cubic feet, then one cubic foot will weigh 1/333 pound. Now if we divide 333 into 1, we get

333) 1.000 (.003003
999
1000

which is given in the fourth column. We see then that the fourth column is the reciprocal of the third or the value of the third column divided into 1. Similarly if one cubic foot of steam at the pressure considered weighs .003 of a pound, then one pound of steam will occupy .003 divided into 1 or
.003) 1000 (333
and the third column is the reciprocal of the fourth.

The next column is the heat of the liquid. Now this heat of the liquid is the actual number of B. t. u. contained in the water at the temperature and pressure named, reckoned from 32 Fahrenheit. Here it must be observed that the column marked t, gives the temperature in degrees Fahrenheit measured from 32, while the column marked i, or heat of liquid, gives B. t. u. above 32. This is a point where many mistakes are made, because in considering the heat of the liquid many men merely take the temperature and subtract 32 from it. This will not give the correct result, except when the steam is in the neighborhood of atmospheric pressure, and the reason is this: the specific heat of water alters as its maximum density is departed from. Now take the example we have before us. The temperature of steam at one lb. absolute pressure is 101.83 degrees Fahrenheit. The heat of the liquid, or the heat contained in the water in contact with the steam is 69.8 B. t. u. above 32. The difference between 101.83 and 69.8 is 32.08, which is practically the same as 32. Turn now, however, to steam at a pressure of 49 lbs. absolute. The temperature is 279.8, while the heat of the liquid is 248.8. Subtracting 32 from the temperatures gives us 247.8, which is a difference of 1 B. t. u. from the heat given in the table. If we take steam at 150 lbs. absolute pressure we find that the temperature is 358.5, while the heat of the liquid is 330.2. Subtracting 32 from the temperature would only give 326.5, the difference being 3.7 B. t. u.

The alteration in the specific heat means that above and below 39.1 degrees Fahrenheit one pound of water requires less than one B. t. u. to raise it one degree Fahrenheit, and therefore there is more actual heat than is represented by the temperature.

If we divide the degrees above 32 in the temperature which will be 326.5 by the heat in the liquid, it will give us the specific heat of the water.

330.2) 326.5 (.9857
29718
28320
26416
19040
16510
25300
23114

Similarly if we divide the temperature above 32 by the specific heat we will get the heat of the liquid
9857) 3265000 (330.12

It will thus be seen that it is important to take the heat of the liquid rather than the temperature minus 32 degrees if accurate results are required.

We now come to the column which gives latent heat, and this is, of course, in B. t. u. This represents the quantity of heat that must be added to water at the temperature corresponding to the pressure, before it will become steam at the same temperature and pressure. This heat is called latent because it does not appear as an addition to the temperature of the steam, but is absorbed by the steam, and represents the larger part of the energy of the steam. Before steam can be condensed this latent heat must be carried away or given up, either to circulate water, or by performing work on which the heat is expended.

The total heat contained in the steam is given in the next column. This total heat is the sum of the latent heat and the heat in the liquid above 32, and represents the energy available in the steam to be turned into the work. The equivalent of one B. t. u. is 778 foot pounds of work, and therefore steam at 14.7 lbs. absolute, contains in each pound weight a total quantity of energy represented by 1150.4 x 778, which is 895.011.2 foot pounds. If we could extract all this energy in one minute it would represent 27.1 horse power, but unfortunately we cannot do anything of the kind. If we use the steam in an atmospheric exhaust engine we have to reject unused all the latent heat, besides losses by radiation in the engine and before it gets there. If we lose nothing but the latent heat rejected in the exhaust we would only get about 15 per cent. of the energy from the steam, but in actual practice we get considerably less than that. However, we do not want to go into that question just now.

Internal Energy of Steam

In the table under consideration there is a column which gives the internal energy of steam at the latent heat of evaporation. This internal heat energy requires a little explanation, but can readily be understood by a simple calculation.

Let us take a cylinder whose area is exactly one square foot and whose height is 26.79 feet. The volume of this cylinder would be 26.79 cubic feet, and this is the exact volume of one pound of steam at atmospheric pressure.

Let us suppose that one pound of water at 32 degrees Fahrenheit is lying in the cylinder, and that we apply heat to this water until it is all turned into steam. The pressure of the atmosphere may be represented by a frictionless piston, lying on the top of the water, whose weight is just equal to 14.7 x 144, this being the pressure of the atmosphere on the surface of the water.

The volume occupied by the water before heating will be 1/62.5. This is obtained from the fact that one cubic foot of water occupies 62.5 cubic feet, and therefore the volume of one pound of water will be 1/62.5 part of that. This works out to .016, which will represent the height of the surface of the water in the cylinder before heating is commenced.

We now apply heat to the water, and after we have added 180 degrees to it, the temperature reached 212, or boiling point. This addition of heat is sensible, inasmuch as it appears on the thermometer, and has been expended in raising temperature. After this point is reached, a further 970.4 B. t. u. must be added to make the water at 212 degrees into steam at 212. When this is done, the cylinder is filled with steam and the piston has been raised to the top. Let us see what this means in energy expended.

We have a total quantity of heat in the steam of 1150.4 B. t. u. The latent heat is 970.4. The height that the piston has been raised will be 26.79 less .016, or 26.774 feet. This is equivalent to raising a weight of 14.7 x 144 through a height of 26.774 feet and the energy expended in doing this is equal to

$$\frac{14.7 \times 144 \times 26.774}{778} \text{ B. t. u.}$$

This works out exactly 72.8 heat units, and this represents the external energy or the energy expended by the steam in overcoming the resistance of the atmosphere while expanding. The energy remaining in the steam will be 970.4 less 72.8 which is 897.6 B. t. u.

This is the explanation of the column "Internal Energy."

Using the Table

A typical example of the use of the steam table may be found in the formula for finding the saving by heating feed water. The saving effected is, of course, the difference between the heat added in the feed heater and the total heat added to the feed water to bring it to steam at the boiler pressure. This formula is given as follows:

$$\frac{T_2 - T_1}{S + L - T_1} \times 100$$

in which T_2 is the temperature of the water leaving heater, T_1 is the water entering the heater, S is the temperature of steam and L is the latent heat.

Suppose we have cold water at 40 deg. raised to 160 deg. in the heater, and steam is at 45 lbs. absolute.

We have

$$\frac{160 - 40}{274.5 + 928.2 - 40} \times 100$$

$$= \frac{120}{1162.7} \times 100$$

which gives 10.3 per cent saving. Now suppose we take instead of the first formula, a similar but not quite identical one.

$$\frac{(T_2 - 32) - (T_1 - 32)}{S + L - (T_1 - 32)} \times 100$$

In this case S is the total heat in steam instead of the temperature, and the other quantities are taken above 32 degrees instead of above zero.

We have

$$\frac{(160 - 32) - (40 - 32)}{243.4 + 928.2 - (40 - 32)} \times 100$$

$$= \frac{120 \times 100}{1163.6}$$

The result is practically the same. It will be noticed that the result of the top line is not affected by subtracting 32 from each term. It is only the bottom line that is affected, and only to the extent of the difference caused by the specific heat at the higher temperature.

This difference will be greater the higher the pressure of steam carried in the boiler.

Another example of the use of the table would be as follows:—What is the resulting temperature when 50 lbs. of steam at 125 lbs. pressure are mixed with 100 lbs. of water at 60 degrees, the mixture taking place at atmospheric pressure?

We see that the temperature of the steam at 125 lbs. is 355.1 degrees, while the latent heat is 867.6. The total heat above 32 is 1192.2 B. t. u. However, as the steam and water are to mix at atmospheric pressure, whatever steam is condensed will be condensed at atmospheric pressure, and its latent heat will be 970.4. Therefore we see that the steam must give up a certain quantity of heat in falling from 353.1 to 212 before any condensation will take place. Now if we consider the drop in temperature from 353.1 to 212 as purely a temperature drop the difference is 141.1, and this is the amount of heat given up by each pound of steam in falling from 125 lbs. to atmospheric pressure, and in condensing a further 970.4 B. t. u., will be given up so that each pound of steam in condensing will give up to the water 1111.3 B. t. u. Now if we take instead the quantity of heat above 32 in the steam at 125 lbs. we get 1192.2, and the total heat above 32 at atmospheric pressure is 1150.4 so that the heat given up in falling from 125 to atmospheric would be 41.8, and in condensing a further 970 4 would be given up. the total heat given up being 1111.8 B. t. u. The difference in the two methods is but slight, but it exists. As a matter of fact, in considering problems dealing with the temperature of a mixture, the first method dealing with the temperatures direct instead of considering the total heat above 32 are usually accurate enough.

In the problem stated here, we can say

Heat given up by steam in falling from 353.1 to 212 per lb. .. 141.1
Heat given up by steam in condensing 970.4 ..... 970.4

1111.5

Heat per lb. of water from 60 to 212 is 152 B. t. u. and as there are 100 lbs. of water, 15200 B. t. u. will be required to raise the water to 212. There are 50 lbs. of steam, and the total heat given up if it were all condensed would be 55575 B. t. u. Therefore after the water is raised to boiling point there would be 40375 B. t. u. still available, and if we divide this by 970.4 it will give us the number of pounds of steam not condensed. This comes to 41.6 lbs. steam not condensed, so that the mixture will consist of 108.4 lbs. water and 41.6 lbs. steam at atmospheric pressure.

We can reach this result in another way, by means of a simple equation. We know that the heat taken up by the water will be 100 (212 — 60), which is 15200. We also know that the heat given up by the steam in falling from 353.1 to 212, will be 50 x 141.1 which is 7055 B. t. u. This leaves 15200 — 7055, which is 8145 B. t. u. to be made up and this is exactly the heat given up by the condensation of 8.39 lbs. of steam at 212. This is found, of course, by dividing 8145 by 970.4.

In equation form this would appear as follows:

Heat gained by water = Heat lost by steam.

$$100\ (212 - 60) = 50\ (353.1 - 212) + x970$$

$$15200 = 7055 + x970$$

$$15200 - 7055 = x970$$

$$8145 = x970$$

$$x = \frac{8145}{970}$$

$$x = 8.39$$

This gives the same result as before, 108.39 lbs. of water, and 41.61 lbs. steam uncondensed. There is another method which can be used, as follows:

$$T = \frac{W_1 t_1 + W_2 t_2 + W_2 L}{W_1 + W_2}$$

Where T = final temperature
t_1 = temperature of water
t_2 = temperature of water
L = Latent heat
W_1 = Weight of water
W_2 = Weight of steam

$$T = \frac{100 \times 60 + 50 \times 353.1 + 50 \times 970.4}{100 + 50}$$

$$= \frac{6000 + 17655 + 48520}{150}$$

$$= \frac{71905}{150}$$

$$= 479.36$$

Now we cannot have a temperature of 479.36 at atmospheric pressure. Therefore find how much heat above 212 is contained in the mixture.

(479.36 — 212) 150 = 40104

If we divide this by 970.4 we shall have the quantity of steam not condensed

$$\frac{40104}{970.4} = 41.3 \text{ lbs.}$$

The above examples should give the reader an idea of how the steam table is to be used in all problems relating to the heat of steam, such as occur in questions of feed heaters and exhaust steam heating, quantity of water required for condensing, etc.

It does not pretend to cover the subject, but is merely meant as a guide for those who have had difficulty in finding the quantities required from the table.

SAMPLING DELIVERED COAL

In sampling delivered coal the Bureau of Mines follows a definite procedure. A sample weighing not less than 1,000 pounds is systematically collected by taking equal increments at regular intervals throughout the delivery, while coal is being loaded or unloaded, and crushing and reducing this sample by successive stages to laboratory size. In using analyses of samples of delivered coal, the reader must recognize that the coal is not always of uniform size, and that the impurities are not uniformly distributed throughout the mass. Some variations in the results obtained are consequently to be expected; if the same mass of coal were sampled a number of times the analyses would not agree absolutely except by chance. It is only when a considerable number of such analyses are available representing a considerable tonnage mined over a period of time that the average value and range of variation of a particular coal becomes known with assurance. With reasonable tolerances, however, for these variations, delivered coal can be sampled accurately enough for all practical purposes. Deliveries from any one mine may vary in quality from time to time because of changes in mining or preparing the coal, and an analysis of deliveries for any one date should not be considered as establishing a permanent standard, for the output may be greatly improved by new methods of mining and preparation, or it may deteriorate through the carelessness of the miner and the operator.

The St. Lawrence Co., Ltd., Montreal, who recently became agents for the Queen City Rubber Co., Philadelphia, not only cover Quebec but all of Canada east of and including Ottawa. They also have the right to sell other lines in any other part of Canada should they desire.

Some Elements of Economy in Air Compression

Steam Driven Air Compressors of Single and Compound Types —Electrically Driven Machines—Methods of Lubrication and Governing—Cooling by Water Jacket and Intercoolers—Types of Valves, etc.

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THE IDEAL inlet valve is here outlined. Probably no compressor valve on the market to-day exactly fulfils all these conditions; but many types represent the experienced judgment of the builders applied in an excellent compromise.

The functions of an air discharge valve are to release the full volume of compressed air from the cylinder with the least friction and power expenditure; to keep it all out after discharge, and to continue indefinitely to maintain this duty without undue expense. The primary essentials of such a valve are as follows:

Its opening must be full and instantaneous, must occur just at the right point in the stroke and must be held open until the piston comes to rest. The valve opening must be ample so that the velocity of discharge may not be excessive and the ports and discharge passages should be short and free from obstruction, to reduce friction.

As few parts as possible, and these correctly adjusted, should provide for the necessary valve movement with the minimum loss of power in mechanical friction.

The valve should close instantly and completely as soon as the piston stops, that there may be no return of the air discharged when the piston starts on its back stroke. Such a return of compressed air would have the effect of an increased clearance, reducing the capacity of the cylinder.

The continued maintenance of this performance (which is more arduous upon the discharge valves than upon the inlet valves because of the higher pressure) suggests the advisability of a simple construction with the fewest bearings, careful workmanship, the use of good materials, perfect lubrication and careful distribution of materials. It is always to be remembered that discharge valves and ports are continually exposed to a flow of heated air even where jacketing is most complete. On the other hand, an essential of inlet valves and ports is that they shall be kept cool. The latter should therefore be removed as far as possible from the former, nor should the same ports be used for both inlet and outlet.

It might, at first glance, seem that the area of the discharge valves, ports and passages could be much less than the corresponding inlet area, since the former must pass the air at a higher pressure and in less volume than the latter. But it is to be remembered that while the inlet areas are open during the full stroke, the discharge areas are open for only a part of the stroke—about one-third. In order, therefore, to make the velocity of discharge about the same as that of intake or admission, it is usual to make the inlet and discharge areas approximately equal.

It is important that the velocity of flow through the valves, ports and passages shall not be excessive, and this depends upon the piston speed which is a widely variable quantity. The higher the piston speed, the larger should be the area. In actual practice, the inlet areas vary from 3 to 15 per cent. of the cylinder areas, with an average probably around 9 to 10 per cent. The corresponding discharge areas from 7 to 15 per cent., with an average in the neighborhood of 10 to 12 per cent. The larger these areas, the better the economy. The modern design, the lightness of weight of plate and strip type of valves permit higher velocities than was formerly considered good practice. This is owing to the small differences in pressure required to open the valve and concentration of engineering talent in the correct shape and design in the ports through the air valve to give the least resistance to the air flow.

Owing to the increased friction through a number of small passages as compared with that through a single large one, the actual measured area in the former case should be 50 to 100 per cent. larger than the latter. This explains why the measured inlet area of machines with Corliss or other large area inlet valves is often so much less than the measured discharge area of many small poppet discharge valves, while still giving good results.

It may be well to recall at this point that cylinder clearance is really made up of three elements; the inlet port clearance, which is all the space left between the closed inlet valves and the inner surface of the cylinder, the discharge port clearance, which is the corresponding space in the discharge passage, and the piston clearance, which is the space allowed for safety between piston and cylinder head at the end of the stroke. This latter element is an essential in compressors. But it is not unusual for the other two elements together to constitute by far the larger proportion of the total clearance. This suggests the superiority of those valve designs in which inlet and discharge port clearance are reduced to the lowest practical limit.

Coming now to consideration of the third element in air compression, the mechanical structure, we find that it has a very important bearing upon the economy and the endurance of the machine.

The mechanical efficiency of a compressor can be exactly determined by a comparison of the steam and air indicator cards, (in a steam driven machine) or by a comparison of the measured power applied to the horsepower of the air indicator card (in a power driven machine). The difference between these values represents the power consumed in the friction of the compressor. Good mechanical efficiency, therefore, depends upon the extent to which friction is reduced. There is no time here to enter into the details of compressor design, it will be enough to enumerate some points having a bearing on this subject.

Power should be applied to resistance —steam pressure to air pressure—in as direct a manner as possible, so that bending or deflecting strains may be avoided as far as possible, with the resultant bindings of bearings and loss of correct alignment.

Ample metal should be used, properly disposed to afford the rigidity necessary as a further precaution against the attendant binding stresses, just mentioned. A light construction is always to be avoided.

Lest this correct proportioning of materials to meet stresses should result in an excessive weight and an extravagant cost, these materials should be of the best quality and intelligently selected for specific purposes, affording the maximum strength per unit of weight.

All bearings should be of ample area, so proportioned as to give a safe, moderate pressure per inch of bearing surface.

Wherever possible bearings should be supplied with removable linings (preferably of anti-friction metal). In all cases, whether thus lined or otherwise, they should be scraped smooth and true, properly adjusted and arranged for the ready distribution of lubricant—all of this tending toward a lower co-efficient of friction for these bearing surfaces.

Complete provision should be made for a plentiful supply of lubricant to all bearing surfaces, furnished preferably by an automatic system which will be efficient at all speeds.

The utmost simplicity should be sought throughout, reducing the number of parts, the number of joints, (each an

element of weakness) and the number of bearings with their attendant friction and their possible loss of economical adjustment.

The design should afford a ready accessibility at every point, inviting frequent and careful attention to the maintaining of a correct adjustment of all parts for most efficient operation.

Steam compounding and compound air compression have important effects upon the mechanical efficiency, which have already been discussed in the proper place.

Friction has been aptly defined as "that portion of the power consumed by a machine in wearing itself out." This definition throws on the question of compressor endurance a light in which the importance of a high mechanical efficiency appears in bold relief. True economy is a question not of momentary results but of results covering months and years of continuous service under all conditions; and a compressor in which the percentage of "wearing out power is least," promises not only the highest, but also the longest record of sustained economy and satisfactory service.

Governors

While the regulating devices or governors used on air compressors vary in detail among the different builders, all may be divided, as far as the principle of operation is concerned, into two classes.

The first class is that applied to compressors with plain or adustable cut-off valves of flat or piston type. It operates by throttling the steam supply as load diminishes. Devices in this class consist fundamentally of a valve in the steam pipe, which is opened or closed by action of a piston in a cylinder, this piston being actuated by air pressure from the receiver. The movement of this piston is opposed by weights on a lever or by a spring, and the spring tension or the weights may be adjusted so that the governor valve is full open at any desired normal air pressure. But when pressure exceeds this limit, the tension of weight is overcome, and the valve in the steam supply is closed in a degree corresponding with the amount of excess pressure. This slows down the machine and reduces the volume of air discharged until such time as the normal pressure is reached, when the weights or spring tension again open the governor valve, and full speed is restored.

The second class includes governors applied to machine with Corliss steam valves. The mechanism consists of a pressure cylinder and piston with opposing weight or springs as described in the preceding paragraph, but in this case the movement of the governor, instead of throttling the steam, changes the cut-off of the steam valves, reducing speed under partial load, and restoring it as load increases. The resistance per stroke being the same throughout, a very slight change of cut-off, hardly affecting the economy, produces all the speed change necessary.

Both of these classes of governors include also a speed-limiting device, the more common form being the familiar fly-ball arrangement, which throttles the steam supply or greatly shortens, the cut-off when speed exceeds a certain limit, as it might in case an air pipe should break or other accident occur.

There are occasional instances in which governors of one or other of the above classes are used in connection with an unloader on the air end, so arranged that, as the speed falls off, the load is partially taken from the air end. These are the specialties of individual builders, and as such cannot be elaborated upon here. The two general classes defined cover the general requirements of this paper.

Since the power driven compressor is almost always a constant speed machine, the methods of regulation and governing described for variable speed steam driven machines evidently cannot here be applied. Constant speed means constant piston displacement, and the problem of delivering a variable volume of air with constant piston displacement, becomes one of making a portion of that displacement non-effective in the compression and delivery of air. Only the fundamental principles of several methods of accomplishing this will here be discussed.

The first method is really one of unloading, rather than of regulating. A pressure controlled mechanism is arranged so that when pressure exceeds normal due to excess of delivered volume over demand, a communication is opened between the two sides of the compressing piston. Usually this is accomplished by opening and holding open one or several of the discharge valves at both ends of the cylinder, the air then simply sweeping back and forth from one side of the piston to the other through the open valves and the air discharge passage. When normal pressure is restored, the valves are automatically closed, and compression and delivery are resumed. Evidently this is practically a total unloading of the machine for a longer or shorter period—a sudden release from load and a sudden resumption of load. Moreover, the air which is swept back and forth by the piston in its travel is air under full pressure, so that when the discharge valves suddenly close, the piston at once encounters a full cylinder of air at maximum pressure. These facts limit regulators of this class to machines of comparatively small capacity.

Another method provides by means of a pressure operated device for the total closing of the compressor intake under reduced demand. This form of unloading consists of a double disc valve on the intake of the compressor which closes completely when the desired air pressure is reached and prevents any more air being drawn into the cylinder. Owing to its construction it is always wide open or entirely closed, the movement of the valve being complete and quick so that there is no wire drawing or throttling of the incoming air. The operating device or auxiliary valve controlling this form of unloader is governed by means of a needle valve or separate auxiliary operating valve either of which operate when the desired air pressure is reached for which these valves are set.

When compressors are operated unloaded for long periods without resuming their load, the addition of a cylinder relief valve can be applied to keep down excessive temperatures. When these relief valves are applied they are operated simultaneously with the closing of the intake unloader. Their use permits entirely unloading the air cylinder by opening each end to the atmosphere. The use of cylinder relief valves is more particularly beneficial on straight line compression and where the ratios of compression are high.

A further modification of the use of the intake unloader has been developed by one of the large builders using the intake unloader in combination with a discharge line unloader for two-stage compression. The discharge line unloader is never used alone but only in connection with the intake unloader when it is desired to attain the greatest possible reduction in horsepower during unloading periods. It is connected directly to the discharge opening on the high pressure cylinder in such a manner that the flow of air through the device to the cylinder is to the atmosphere. The operation is instantaneous, opening a passage directly from the high pressure cylinder discharge passage to the atmosphere when unloaded. This is accomplished by opening a pressure operated valve which is controlled by the same auxiliary valve as controls the intake unloader. When the pressure operated valve is opened communication between the discharge passage from the high pressure cylinder is direct to the atmosphere and the air in the pipe line and receiver are held back by an automatic closing check valve. On the resumption of demand, the intake unloader opens and simultaneously the pressure operated valve in the discharge line unloader closes and the air is passed on to the receiver.

The third method is very similar to the first except that here the inlet valves instead of the discharge valves are held open when the machine is unloaded and in single stage machines the piston simply draws in and forces the air out to atmosphere. In the case of two-stage compression some or all of the inlet valves at each end of both the high and low pressure cylinders are held open. In the case of the low pressure cylinder the air is exhausted through the suction passage back of the atmosphere and the cool clean air is sent back and forth into the low pressure cylinder after the first air is exhausted. In the case of the high pressure cylinder the air is exhausted back into the intercooler and the piston sweeps back and forth in a balanced condition. This system of regulation can be applied in two steps on two-stage compressors so that half of the low pressure cylinder and half of the high pressure cylinder can be cut out at

a given pressure and the second half of the low pressure cylinder and the second half of the high pressure cylinder can be cut out at a slightly increased pressure. This form of regulating gives a regulation on the basis of "no load," 50 per cent. load and "full load." In this system of regulating, when the pressure drops to a predetermined point the valves are automatically closed and compression of delivery resumed. This form of regulating and unloading is applicable to single stage compressors and to two-stage compressors. It is also possible to use this form of regulation on steam driven compressors of the straight line type in combination with combined speed and pressure governors, where separate controlling or operating valve is used, which first acts on the steam governor slowing the machine down to a pre-determined number of revolutions per minute, after which the free air unloader will come into action and fully unload the machine. In the loading condition the free air unloader is first closed with a further drop of pressure the governor brings the compressor up to its rated speed.

The most superior method of regulation known to compressed air engineers and usually employed on two-stage compressors above 1,000 cu. ft., provides auxiliary clearance spaces or pockets at each end of the cylinder which successively cut in as the load diminishes. The excess air is simply compressed into these clearance spaces and expanded on the back stroke. The capacity of the cylinder is reduced without any appreciable waste of power, for the energy used in compressing the clearance air is given back by its own expansion. A big advantage of this type of unloading is that it is the only known method of unloading a two-stage compressor of two cylinders in four definite steps and still maintain both sides of the machine in balance. This is a particularly desirable feature on larger compressors where it is usual to employ direct connected synchronous motors. It might be said that a four step definite unloading can be accomplished with the free air unloader by using two low pressure and two high pressure cylinders.

In the clearance control method of unloading the practice is to have two clearance pocket control valves at each end of each cylinder which are controlled by an auxiliary valve. The accomplishment of four step unloading is caused by the auxiliary valve first opening up one valve at one end of the low pressure cylinder together with one valve on one high pressure cylinder at the same moment. This gives three-quarter capacity. A slight increase in the air pressure causes the auxiliary valve to open up one clearance control pocket in the opposite end of the low pressure cylinder together with reciprocal pockets at the opposite end of the high pressure cylinder.

A further increase in pressure operates the third stage bringing the load down to a quarter by means of opening up a second clearance valve on the low and high pressure cylinders on the same end on which the first stage was accomplished. A still further increase puts the compressor into fully unloaded condition by opening up the last clearance pockets which are located on the same end that accomplished the second stage or half load condition. As the demand for air increases the load comes on in steps in the reverse order.

In the odd cases where it is found advantageous to operate the compressor by means of automatic start and stop control electrical devices, special means must be taken to insure the compressor is unloaded when starting up from a position of rest with pressure in the air receiver. There are several methods of accomplishing this, and we shall only attempt to describe two or three of these.

One is by means of an electrical solenoid operating valve. This is somewhat of an expensive apparatus. Compressed air engineers have developed an entirely mechanical method which is cheaper than the solenoid method, which is operated by means of pilot valves attached to the indicator openings which operate a specially designed discharge line unloader. These operating valves are controlled by a peculiar air action in the cylinder at the moment the machine comes to rest and do not permit the discharge line unloader to allow the air to be pumped into the receiver until the compressor is up to speed.

On small vertical compressors which are very frequently used with automatic start and stop control a very simple device has been designed which operates by means of centrifugal action. The weights of the centrifugal unloader are attached to the end of the crank shaft and when the compressor comes to rest these weights control the operating rod which holds the inlet valve open. When the compressor is up to speed the inlet valve resumes its usual function.

On power driven compressors with Corliss intake valves, several different methods of unloading or regulating are used.

By one method the Corliss valve is held open for the full admission stroke, and also a part of the compression stroke, this latter portion being determined by the unloading called for. Evidently this is practically equivalent to a shortening of the stroke of the compressor.

By another method the Corliss intake valve is opened full at beginning of admission, but closes later in the admission stroke. The air admitted to that point is expanded or rarefied for the remainder of the compression stroke, and then compressed, the volume of compressed air delivered being of course reduced. This arrangement is productive of an excessive temperature range in the cylinder. Still a third method opens and holds open the intake valves at the end of the cylinder, or at opposite ends in duplex machines. The effect of this is to make ineffective one out of every two strokes. If still further unloading is necessary, the intake valves at the other end of the cylinders or cylinder are opened and held open. The three arrangements just outlined all operate by a pressure controlled mechanism which actuates some form of trip on the Corliss air valve gear, somewhat similar to the release mechanism of the Corliss steam valve for varying the cut-off.

Things to be Avoided

Three things are to be avoided in the successful unloader or regulator for power driven machines, first, a sudden release or resumption of load, throwing heavy strains on the machine; second, undue rarification of the intake air, resulting in a wide range of cylinder pressures and temperatures, third, the blowing off of compressed air to the atmosphere with a waste of power.

In the regulation of the power driven compressor, less reliance must be placed upon the automatic regulation of the individual machine than upon the intelligent subdivision of the load between two or more machines and upon the careful management of the resulting plant. In designing a plant of these machines, maximum capacity must be cared for in the normal output of the machine while partial loads are provided for by starting or stopping one or more machines, the remainder running at or very near full load. It is usually desirable to start a power driven compressor with no load, throwing on the load gradually after normal speed has been reached. This is, in fact, essential in machines driven by electric motors, for the heavy inrush of current in starting under load is dangerous, particularly where power is taken from a transmission circuit supplying other motors.

Evidently almost any of the unloading devices noted in the previous section can be used for this purpose if properly arranged for manipulation. The usual form, however, is simply a by-pass valve to atmosphere on the line close to the compressor protected by a check valve between it and the receiver to prevent the return of air from the line when the starting unloader valve is open. This check valve is essential where several compressors serve one line, permitting cutting in or out any machine without unloading the others. This by-pass valve is open on starting, when the compressor simply compresses to a pressure sufficient to open its discharge valves, this air escaping to atmosphere. When normal speed is reached, the by-pass or unloading valve is gradually closed and load resumed. On two stage machines, an unloader valve should be provided on the low pressure discharge of the intercooler, as well as on the high pressure discharge to the line. In the latter case, both cylinders operate momentarily as low pressure cylinders.

Horse Power of Gas Engines and Motors

The Method of Determining Brake Horse Power on Those Types of Engines Which Cannot Readily be Indicated, and on Electric Motors by the Dynamometer or "Prony" Brake

SMALL and medium sizes of gas engines and motors naturally call for a simple, cheap, and at the same time accurate method of ascertaining the horse-power developed and delivered to the lineshafting. This will consist of some form of dynamometer, which is generally the friction brake. Whether an engineer is likely to be called upon to make a test of this kind or not, it is a good plan to know how to do it, because of the satisfaction of knowing that should occasion require it he will be prepared to undertake the work

The simplest forms of brake and the cheapest constructions only will be illustrated, since they are not only more readily comprehended in a short time, but where an expensive outfit is required the owner of the engine, and sometimes the engineer also, prefer to take the builders' statement concerning the power and the economy to be obtained, instead of going to the expense of obtaining the necessary apparatus for a test.

One of the simplest and the cheapest forms of brake is the rope or differential brake, shown in Fig. 1. The pulley employed with this brake preferably has raised edges or flanges on the rim to prevent the rope from slipping off sidewise. Grooved pulleys are, of course, more perfectly adapted to the use of the rope brake, but it is applied with good results to the ordinary form of pulley face. If a flanged pulley is not conveniently obtained, the rope may be run through blocks of wood, the blocks having depending edges forming short sections of flanges, which prevent the rope moving sidewise. The method of increasing the tension on a rope will no doubt be determined by circumstances. A familiar method of doing this is shown in Fig. 1. One end of the double rope is hooked on to the lower end of a pair of spring scales, and the scales suspended from the short arm of a lever of convenient length, which is fulcrumed upon a bracket from the ceiling above or upon a trestle constructed expressly for it. The opposite end of the double rope is hooked on to the end of a lever fulcrumed at the middle, so that it is approximately balanced. The end opposite the brake rests upon the platform scales, as shown.

After starting the engine and getting the proper speed, the free end of the upper lever is gradually pulled down, which wraps the rope tightly around the pulley, and the friction tends to carry the rope around with the pulley, which tendency is overcome by the lever below. The stress created in the rope by the tendency of the latter to revolve with the pulley is measured by the platform scales, the scales being constantly adjusted so that the beam is kept in equilibrium or balance.

The indications of both scales are noted frequently, when the scale beam is exactly balanced and a record kept throughout the run. The power may be figured shortly after starting the engine, and if it is not high enough the lever may be pulled down a little farther, and the power again computed, and so on until the maximum power desired is reached. It is desirable to proceed in this manner when the volume of gas consumed per horse-power is to be obtained for several different loads. When only the maximum power is desired the rope can be tightened nearly to the proper point by noting the position or the action, as the case may be, of the governor. Then, when it is thought the full load has been obtained, the horse-power may be quickly computed and the amount of gas used from this moment on kept account of.

When finding the horse-power of the engine by means of the differential brake, the difference between the readings of the two scales is taken, and this represents the stress on the rope. The horse-power is found by the formula:—

$$\frac{D \times 3.1416 \times R \times S}{33{,}000} = \text{H. P.};$$

in which D = the diameter of the brake pulley, R = the revolutions per minute; and S = the stress on the rope previously mentioned. It is important that the calculation of the horse-power be performed as quickly as possible when increasing it from zero to the maximum, because the rope cannot be used continuously for long runs. To aid in doing this it is a good plan first to find the horse-power constant of the particular engine being tested. This is represented by the formula:—

$$\frac{D \times 3.1416 \times R}{33{,}000} = \text{H. P. constant.}$$

All that is necessary now when computing the horse-power is to find the difference between the readings of the scales, or the value of S, and multiply it by the constant, which can be done in about one-fourth the time necessary to use the entire formula.

When keeping account of the maximum values only, throughout the run, the average of these values will be used which is represented by the sum of the readings of the platform scales minus the sum of the readings of the spring scales and the difference divided by the product of the number of readings taken multiplied by the number of minutes. This rule in the form of a formula is:—

$$\frac{R - r}{M \times N} \cdot \text{average value of S.}$$

In this case R = readings of platform scales, and r = readings of the spring scales; M = number of minutes, and N = number of readings. The differential rope brake is applicable to engines of from 1 to 5 or 6 H. P., and may be rigged up in a short time with materials generally to be found in manufacturing plants.

Another simple form of brake is shown in Fig. 2. This, in principle, is the same as the rope brake, the calculations being the same. In the latter brake a strap is used instead of the rope, which may be a piece of leather belting reinforced at the ends for the reception of the hooks.

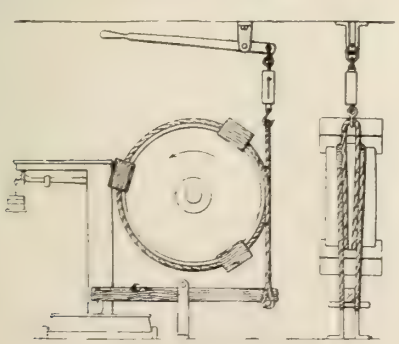


Fig. 1.

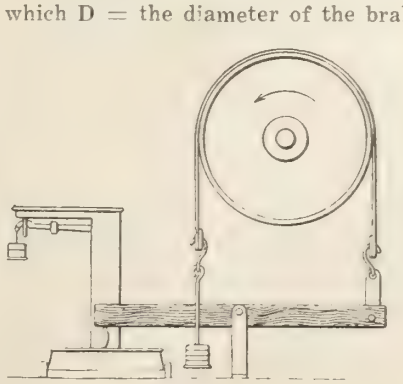


Fig. 2.

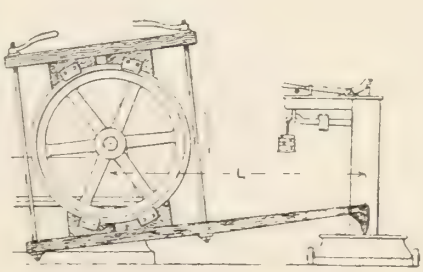


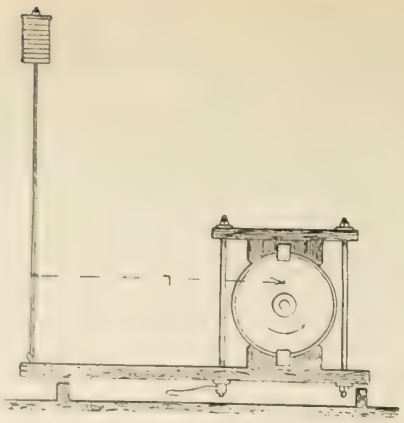
Fig. 3.

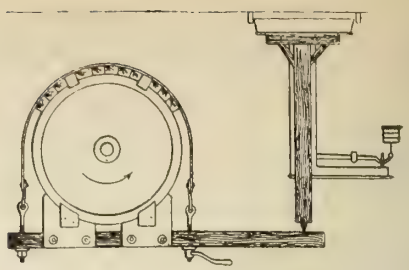
Blocks of wood may be fitted over the belt in practically the same manner as in the case of the rope brake to keep the belt from slipping off the pulley. For larger engines, say from 5 or 6 H. P. upward, the Prony brake illustrated in Fig. 3 is the better construction. While the brake is fully as simple when once constructed, it is, of course, a trifle more expensive, and will require a little longer time to rig it up. It consists of two or more blocks of wood bolted to suitable strips for the purpose of keeping them in position. The lever employed for weighing the resistance generally serves as one of these strips as shown. Ears are bolted on at the top and bottom, and project toward the hub of the wheel or pulley and about an inch beyond the rim of the pulley. These prevent the blocks from slipping off the pulley. Two heavy bolts run through the projecting ends of the upper cross-piece and also through the lever, with washers and nuts at the lower ends. The upper ends are provided with washers and lever nuts, or wingnuts as they are sometimes called. The outer end of the lever rests upon the scales, which are adjusted to balance the weight of the lever and the vertical bar supporting it.

After starting the engine and obtaining the desired speed, the lever nuts are tightened by hand until the desired resistance is obtained, or nearly so, the weights on the scale beam at the same time being put on so that as soon as the desired load has been obtained the scales may be quickly balanced and the weight indicated by them recorded. When the scales get out of balance, due to wear at the blocks, the latter must be tightened a very little so as to restore the balance of the scale beam without having to readjust the weights on the beam. It generally requires but a slight turning of the lever nuts to bring the scales into balance again, and it is usually impracticable to turn these nuts so slight an amount by hand. A less force than is necessary to move the nuts will frequently be sufficient to bring the scale beam into equilibrium, so that as soon as the nut is released the scales are immediately out of balance again. A light hammer is preferable when making these adjustments, giving the lever of the nut a slight tap, which will generally be found sufficient to move the nut without disturbing the scales other than by the increased resistance due to tightening the blocks on the pulley.

The brake blocks may be lubricated by water thrown upon the pulley surface by means of an ordinary squirt can, or the blocks may have grooves cut in the faces, of practically the same form as in the brasses of an engine connecting rod. The lubricant in this case may be a heavy grease which fills the grooves and is evenly distributed by them.

The calculation necessary with this form of brake differs but little from the calculation previously given. In the first place, the length of the lever L,





Figs. 3 and 5, is measured between the centre of the shaft and a vertical line passing through the point of support on the scales. The formula for horse-power is:—

$$\frac{D \times 3.1416 \times R \times (L \div r) \times W}{33{,}000} = \text{H. P.};$$

in which D = the diameter of the pulley; R = the number of revolutions per minute; L = the length of the lever resting upon the scales; r = the radius of the pulley; and W = the weight indicated by the scales. Another formula in common use is:—

$$\frac{2 \times L \times 3.1416 \times R \times W}{33{,}000} = \text{H. P.},$$

the notation being the same.

As in the former case, it saves time and is much more convenient to use the horse-power constant instead of employing the entire formula each time the power is obtained during the run. The horse-power constant in this case is obtained by the formula previously given, except that the value of W or the weight indicated by the scales is unknown beforehand, and therefore is omitted from the formula. The result of the formula will then give the horse-power for each pound indicated by the scales, so that when finding the horse-power at each adjustment of the brake it is only necessary to multiply the constant by the weight indicated by the scales; the result will be the horse-power delivered at that moment or while the scale beam is in equilibrium.

Still another form of brake suitable for engines of medium size is shown in Fig. 4. This is called the Prony strap brake. It consists of the lever and two blocks at the top, and a strap partly surrounds the pulley, having a number of smaller blocks attached to it on the underside of the pulley. Two or more ears are attached to the strap or to the blocks to prevent the latter from working off the pulley. The strap is fixed at one end and connected to an adjustable bolt at the other, the bolt extending through the lever, and is provided with a washer and lever nut. This brake is lubricated in the same manner as the others by means of water applied with a squirt can or a heavy grease. The blocks should be grooved when the latter is employed. The method of adjusting the screws and the necessary calculation are the same as with the two-block or four-block brake.

Some persons prefer to measure the power delivered from the lineshaft, instead of from the engine. When this is required the arrangement of brake illustrated in Fig. 5 is frequently found convenient. The brake may be either the block or strap construction. The lever lies at right angles to the direction of the weight cord when the weight is raised from the floor and the lever is in equilibrium. The lower disc or weight may be heavy enough to hold the lever in the position shown when the friction blocks are sliding loosely on the pulley. The effect is practically the same as when balancing the horizontal lever on the scales when the brake is running loosely on the pulley. The weights added at the bottom are the ones used in the calculation. These should be added as fast as the brake screws are tightened, so as to keep the weight suspended or just off the floor. The calculation of the horse-power with this arrangement is the same as with the brakes illustrated in Figs. 3 and 4.

These styles and constructions of brake represent the principal forms which can readily be made by the engineer or carpenter in almost any plant, and when carefully handled give results approximating the results obtained with more elaborate and costly apparatus. The whole brake should be made strong, yet as light as possible, and for this purpose poplar is a fairly good wood to use for the blocks, which are the heavier parts of the brake.

The friction brake or dynamometer does not furnish a means of finding the total horse-power developed by a gas engine, but the horse-power obtained from it. In order to find the horse-power developed by the engine itself, or the indicated horse-power, as it is called, it would be necessary to use the indicator. The application of the indicator to the steam engine is familiar to all. The application to the gas engine is made in much the same manner. Sometimes the indicator port is located in the clearance space, the instrument then being placed

either on top or at the side of the cylinder, while in other engines the port is in the cylinder head. The drum cord is attached to any convenient part of the engine that moves in unison with the piston so as to impart to the drum an exact reproduction of the piston movement.

It is not intended to go into the work of taking diagrams and finding the mean effective pressure, because that should properly be treated in a separate article. In connection with the formulae for finding the horse-power constant used when applying the brake, those to be used when applying the indicator may be added. For the two-cycle engine, in which the speed is governed by throttling the supply of gas, the formula for horse-power is:—

$$\frac{P \times L \times A \times N}{33{,}000} = \text{H. P.}$$

In the four-cycle engine governed in a similar manner the formula is:—

$$\frac{P \times L \times A \times \frac{1}{2} N N}{33{,}000} = \text{H. P.}$$

For the four-cycle engine operating on the hit-and-miss principle the formula is:—

$$\frac{P \times L \times A \times E}{33{,}000} = \text{H. P.}$$

In the case of the former engines the value of P or the mean effective pressure will under ordinary circumstances be the unknown quantity, and the formula for the horse-power constant becomes:—

$$\frac{L \times A \times N}{33{,}000} = \text{H. P. for 1 lb. mean effective pressure.}$$

In engines operating on the hit-and-miss plan there are two unknown quantities—viz., the mean effective pressure and the number of explosions per minute. The constant in this case is:—

$$\frac{L \times A}{33{,}000} = \text{H. P. for 1 lb. mean effective pressure and for one explosion per minute.}$$

It will be understood that this refers to the average mean effective pressure from the several diagrams taken.

The letters in the foregoing formulae represent the following quantities: A = area of piston in square inches; L = length of stroke in feet; N = number of revolutions per minute; P = effective pressure in pounds per square inch; and E = the number of explosions occurring per minute.—"Southern Engineer."

HEATING BOILER FUELS

Technical Paper 303, "Value of coke, anthracite, and bituminous coal for generating steam in a low-pressure cast-iron boiler," by John Blizard, James Neil, and F. C. Houghton, has just been issued by the Bureau of Mines.

The primary purpose of the tests described in this paper was to determine the relative steaming values of coke, anthracite, and bituminous coal when burned in a low-pressure boiler, and fired by hand in fairly large quantities at a time.

A secondary purpose of the tests was to separate the heat losses, and to examine them carefully to determine the change in efficiency with the method of firing the fuel and manipulation of the draft dampers, with the rate of evaporation, and with the various fuels burned.

Other purposes were the determination of the draft used, temperatures and composition of the gases in the flues, furnace, and combustion chamber, and other factors affecting the operation of the boiler.

Before these tests were completed, some special tests were run at the request of the Chamber of Commerce of Pittsburgh, to compare the steaming value and smoke emission of mixtures of coke breeze and Pittsburgh coal with those of the latter alone; results of these tests are also embodied in this report.

Tests were made at different rates of steaming with coke, anthracite, and bituminous coal. Two tests also were run with a mixture of equal weights of bituminous coal and fairly coarse coke breeze, and two more with a mixture of equal weights of bituminous coal and a finer coke breeze. The calorific value of the coke ranged from 10,700 to 11,900 B. t. u. per pound; of the anthracite from 11,700 to 13 300 B. t. u.; of the bituminous coal from 12,900 to 13,900 B. t. u.; and of the coke breeze-bituminous coal mixture from 11,200 to 11,800 B. t. u. The bituminous coal contained less ash than the coke or anthracite, about the same proportion of moisture, and, of course, far more volatile matter.

The mean steaming values of the coke, anthracite, and bituminous coals were about the same. At the low rate of steaming the coke and anthracite evaporated more water than the bituminous coal, and at the higher rates of steaming the bituminous coal evaporated more water than the coke or the anthracite. The steaming value of the mixture of coarser coke breeze and bituminous coal was about 80 per cent. of that of bituminous coal alone, whereas the mean steaming value of the mixture of finer coke breeze and bituminous coal was lower than that of the mixture of coarser coke breeze.

Technical Paper 303 may be obtained from the Bureau of Mines, Washington, D. C.

DO YOU BUY YOUR OWN BELT DRESSING?

(Copyright, 1922, By W. F. Schaphorst)

A writer in a prominent technical publication recently stated that. "in the old days mechanics were in the habit of making their own glues, cements, belt dressings, etc." However, he went on and said that times have changed and that as a result to-day a great many of our mechanics do not do any mixing at all but buy factory-made preparations.

Then the writer continues and, according to my viewpoint, he inconsistently says:

"Personally I make nothing but belt dressings. For leather belting I use, by weight, two parts of beef tallow and one part cod liver oil. First melt the tallow and allow it to cool until it is little better than lukewarm, then the cod liver oil is thoroughly stirred into it."

He also gives a recipe for rubber belts, which involves red lead, black lead, French yellow and litharge, not to mention boiled linseed oil and japan, etc.

In view of the ingredients used by the above mechanic, the writer is convinced that it would be much better if he would refrain from mixing his own belt dressings also, and purchase a good reliable dressing such as he will find advertised in our trade publications. These dressings do not contain substances that have proven to be actually harmful to belts, such as tallow, boiled linseed oil, litharge, etc.

There are concerns in the United States who have spent a great deal of time and money in the development of belt dressings for all kinds of belts and it is but natural that they should know more about belt dressings than a person who has not made the subject his life study. These manufacturers produce dressings in large quantities, dressings that do not contain the harmful substances, but rather substances that are preservative and that benefit the belt instead of harming it.

The writer does not manufacture dresssings, but has had considerable experience with dressings, both "home made" and factory made and he has come to the conclusion that it pays in the end to buy the best dressing on the market instead of bothering with questionable substitutes. Years ago I did a little house and barn painting and I mixed my own paints, believing that I mixed better paint than could be bought. However, I have since found that I was badly mistaken. To-day the painter who insists upon mixing his own paint, who says that he can mix paints better than can be done by machinery, can safely be put down as an "old fogey."

FIRE HAZARDS IN OIL REFINERIES

Fires in oil refineries may be caused by lightning or other mishap, or by carelessness in allowing the oil or vapors to become ignited, states the U. S. Bureau of Mines in Serial 2,400, just issued. Probably the most frequent cause, however, is the failure of refining equipment. Stills are designed to be safe; and usually are safe. Nevertheless, defects sometimes occur, as in all metal structures, and unless promptly discovered and remedied may result in serious fires and explosions. The dangers of refining crude oil are well recognized, and all modern refineries have developed highly efficient systems of inspection and fire prevention.

Tension and Working Strains of Belt Fasteners

Value as a Transmitting Medium—Only Fraction of Actual Strength of Belt Needed for Delivering Power—Various Grades of Belts Considered—Maximum Load on Fastener

By ERNEST D. WILSON, B.Sc., Ph.D.

THE VALUE of belting for transmission work is determined by its gravity and its horse power transmitting qualities rather than by its tensile strength. If this were not so, it would be comparatively simple for a belting manufacturer to combine certain materials and produce a belt with a tensile strength far beyond any at the present time on the market, but such a belt might have little or no value as a power transmitting medium. It is very interesting to note that in no case, in a very large series of tests conducted by the Mellon Institute and at Cornell University on power factors with the power transmission of belts, has a tension of over 1,000 pounds per square inch been obtained, even under loads several hundred per cent. larger than the rated capacity of the belts. Since the tensile strength of most belting materials is almost invariably more than 3,000 pounds per square inch, it is evident that only a fraction of the actual strength of the belt is needed for transmitting power.

The same thing applies to belt lacing. If strength alone were desired, a fastener could easily be designed which would never let go, but it would have little or no value as a practical belt lacing. Belt lacing should be sufficiently strong to carry maximum loads with a reasonable amount of safety. It should be durable, flexible, smooth on both sides, and should not injure or weaken the ends of the belting. Even though the use of belts to transmit power is very common, few people have a clear conception of just how and why they do transmit power. In studying the strength required of belt fasteners, it is necessary to clearly understand the mechanism and the stresses involved.

Author is consulting engineer of Clipper Belt Lacer Co., formerly of the Mellon Institute, and Chief Engineer Graton and Knight Mfg. Co.

Effective Tension

Consider a belt placed over a pulley and drawn tightly against the pulley surface. If one strand of the belt is pulled harder than the other, either the pulley turns or the belt slips over the pulley surface. The sum of the tensions on both strands of the belt measures the force with which the belt is held against the pulley face and also the friction load on the bearing. The difference in the tensions of the two strands measures the turning force applied to the pulley, and is often called the "effective tension."

As the belt is turning and transmitting power it is easy to see that the highest tension in the belt is the tension of the tight strand and any fastener must be capable of withstanding this tension, with a fair margin of safety to spare. The question then becomes, "What tensions may we expect in a belt carrying its normal load?"

Ratio of Tension Between T. & L. Strands	Effective Tension or Pulling Strain	Tension in Tight Strand	Tension in Loose Strand	Total Tension causing Bearing Friction
6 to 1	60	72	12	84
5 to 1	60	75	15	90
4 to 1	60	80	20	100
3 to 1	60	90	30	120
2 to 1	60	120	60	180

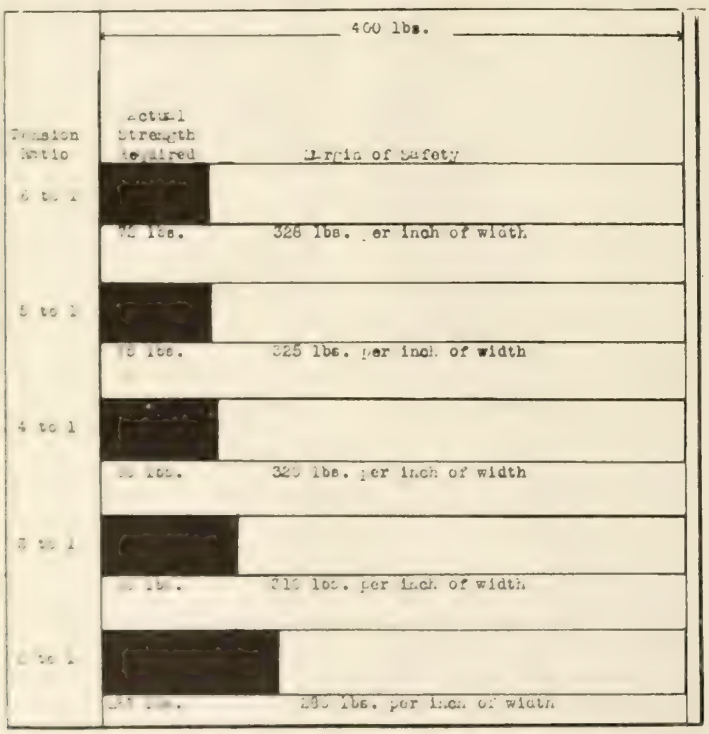
Surface of Belt

The poorer the surface of the belt, the lower is its power-transmitting capacity, and the higher the tension must be to transmit a given amount of power. Belts with good surfaces run constantly with the slack strand actually sagging and show a tension of from ten to twenty times as high in the tight strand as in the loose, whereas when a belt will only allow two times the tension in the tight side as in the loose (which unfortunately is sometimes the case) it is a very poor belt indeed, and has an extremely poor surface.

In the following table the tensions developed with belts of various grades are considered. In each case the belts were run under an effective tension of 60 pounds per inch of width, which is about the maximum recommended by the manufacturers for single leather or four-ply canvas or rubber belt.

In the table given each line shows the tensions which would exist in belts of varying quality as to surface, all 1 inch wide traveling at the same speed, and transmitting the same amount of power. In the second case shown where the tension in the tight strand is 75 pounds, the slack strand carries 15 pounds, and the belt forces the shaft against its bearing with a force of 90 pounds. Contrast this with the extreme case of ratio of two to one. The tight side of the belt must withstand 120 pounds pull and the

(Continued on page 39)



Total strength of efficient belt lacing in a one-inch belt. Black area shows proportion actually required to transmit rated h.p.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field. Steam. Electricity and Refrigeration.

TORONTO, DECEMBER 5, 1922

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INTRODUCTORY

W. B. ROBERTS

W. B. ROBERTS, successor to Thos. H. Fenner, whose valedictory as editor of Power House appeared in the issue of November 20, comes exceedingly well qualified to assume the duties and responsibilities of the position. To readers of this paper it will be of particular interest to know that Mr. Roberts has had practical experience of an exceptional character as stationary engineer. He holds an Extra Chief Engineer's Board of Trade certificate. In 1908 he became associated with the Manchester Steam Users' Association of Manchester, England, first as surveyor and latterly as resident and consultant to the Association. He was with them for five years, when he was in the unique and favorable position of observing numerous tests conducted with a view to promoting economy in the application of steam. Mr. Roberts' subsequent experiences have brought him into close touch with Canadian activities and with the problems confronting Canadian stationary engineers relative to the operation of steam power plants.

In his late capacity as chief engineer and manager to the Boiler and Engine Department of the General Accident Assurance Company of Canada, Mr. Roberts was frequently in consultation with important clients such as pulp and paper companies, manufacturers in many other lines, power stations, etc. Thus, he was called upon for advice in various matters appertaining to engineering, and became familiar with power problems and their solutions in Canada.

It was during the war that Mr. Roberts added a most interesting chapter to his career. In 1915, he was inspector for Alberta and Saskatchewan in the service of the General Accident Assurance Co. He left this position temporarily to join His Majesty's Navy. The manager of the company on that occasion wrote: "It is with great regret that we permit him to leave temporarily, but his country calls him. He is very highly qualified as an engineer, holding an Extra Chief's Certificate, and he wishes to obtain a position in the navy where his service can be used for the good of the Empire." Subsequently, Mr. Roberts served in H. M. minesweepers as Engineer-Lieutenant from February, 1916, and as Engineer Lieutenant-Commander from March, 1919, until demobilization in June, 1919. For a period of twelve months he was employed in the Clyde District supervising the construction of new vessels. There was a programme of twelve H. M. vessels and the shipbuilding yards were very widely spread out, extending on the East coast from Dundee to Hull. This programme was successfully carried through from laying the keel-plate, conducting all the necessary tests and eventually running the final trials. Engineer Commander Chas. J. M. Wallace writes: "He displayed great tact in dealing with the various engineering firms concerned and so expedited the completion of these ships when they were urgently required. Mr. Roberts has shown himself to be a clever and capable engineer and a good organizer."

During the period of his sea service he was chief engineer on six H. M. vessels. The reason for this was that he was unfortunately regarded as "trouble-man" and therefore was being constantly changed about on the various vessels where trouble was thickest. This was during the period of the war when our merchant shipping losses were heaviest and therefore every H. M. vessel that could be possibly kept in commission was kept at work.

On the completion of his work in the Clyde District, Mr. Roberts was appointed to the Portsmouth Base in charge of repairs. Some of his experiences here were unique in view of the fact that he was effecting repairs under great difficulties during the steel shortage. His rank here was Engineer Lieutenant-Commander.

Mr. Roberts is thoroughly conversant with the installation of power plants, consistent with the best modern practice. He has an Extra Chief Engineer's Board of Trade Certificate, which examination is equivalent to the Canadian B. Sc. degree in engineering. He has had wide experience as a draughtsman, and is well up in the theory of engineering.

It is a pleasure to introduce such a one as Mr. Roberts to the readers of Power House. His training and experience, engender the confidence that he is well equipped to appreciate the problems and ambitions of the Canadian field. His wishes are that he be always considered available for consultation, that he welcomes suggestion and helpful criticism, and that, in a spirit of whole-hearted co-operation, he hopes for a full measure of success.

Progress in New Equipment

THE HAUCK Venturi Fuel Oil Burner, see Fig. 1, is a new and improved type of atomizer in which oil is completely atomized or broken up into finely divided fog-like particles by means of steam or compressed air.

The burner consists essentially of a cylindrical casing with slots parallel to the bore axis. These slots form with the inner wall of the casing longitudinal ports or orifices through which the atomized oil is impelled into the furnace. Each port or orifice is a small Venturi tube constricted at its center and flared outwardly at the two ends. The throats or constricted parts of the orifices are connected with the interior of the bore by means of radial openings or apertures.

The oil or tar is delivered under a pressure of 40 to 60 lbs. per sq. in. to the bore, and then passed through the radial apertures to the orifices where it is collided against and blasted by the compressed air or steam.

The compressed air or steam is delivered to the burner at about 80 to 100 lbs. per sq. in. pressure. As it flows through the ports, its velocity increases rapidly and becomes a maximum at the orifice throats. Here it strikes and blasts the oil, atomizes it thoroughly, even by-product tar, and impels the atomized oil from the burner.

The Hauck Venturi Oil Burner secures a thorough mixture of the air and atomized fuel oil at the mouth of the burner. It is correctly proportioned to the oil and steam or air pressures available, is accessible for purposes of cleaning and inspection, and can be conveniently removed from the furnace without affecting the operation of any other burner served by the same piping system.

Reducing, neutral and oxidizing flames are readily obtained merely by manipulating the oil and air valves. The furnace atmosphere is thus closely controlled.

Combustion can be made to take place close to the burner nozzle. Oxygen consequently cannot come into contact with the steel. This results in less scaling. Decarburizing of the work is reduced, and there is less spoilage and greater uniformity of product.

Close control of temperature is accomplished with ease and certainty. The temperature of the furnace is controlled through two standard valves. The labor and attention required are a minimum.

Uniform combustion conditions and ready, exact and simple temperature control increase the efficiency of production. Fewer demands are made upon skill and judgment in the handling of the furnace, and more time and attention can be devoted to the work itself.

The Hauck Venturi Oil Burner is simple to instal and easy to operate. The efficiency of the burner is high and is adaptable to a wide range of work.

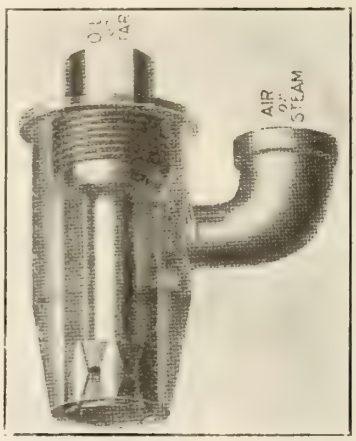


FIG. 1.

The real efficiency of the Hauck Venturi Oil Burner lies primarily in the fog-like atomization it secures, even with by-product tar, and furthermore in the greater convenience it offers in cleaning, adjusting and interchanging parts. It insures that refinement and control of the heating process which is so necessary in modern heat treatment work.

HEAT OF DISTILLATION OF COAL

J. D. Davis, fuels chemist, and Palmer B. Place, junior analytical chemist, of the Pittsburgh, Pa., experimental station of the Bureau of Mines, have developed a precise method for the determination of the heat of reaction of coals during carbonization. Typical coals have been studied for reaction heats over ranges of temperature in which primary decomposition products are formed. The investigation is now being extended over higher temperature ranges where, according to theory, reaction heats should be largely endothermic.

SELF-FITTING KEYS

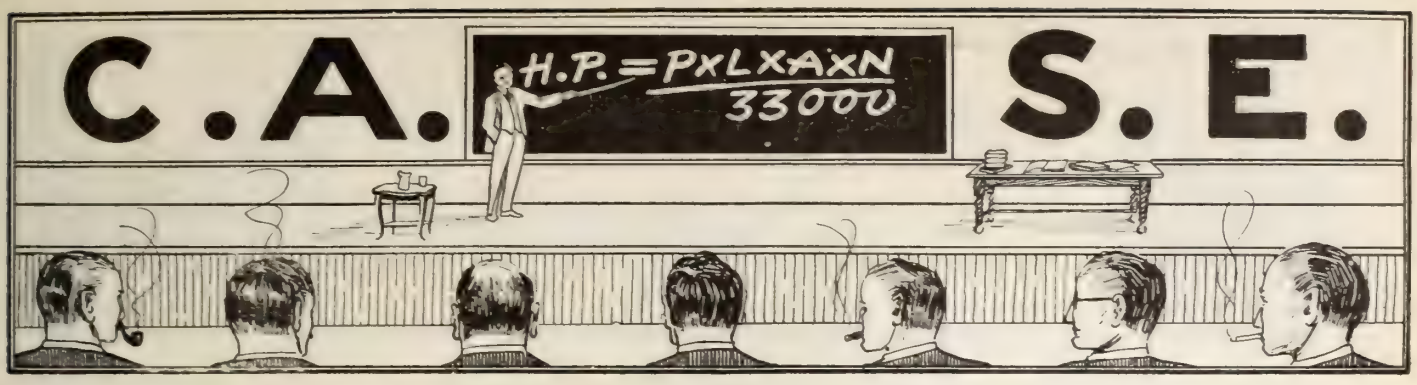
To facilitate the rapid fitting of keys a special type, capable of making its own fit in the keyway by shaving the sides of the latter as the key is driven in, has recently been placed on the market. Owing to the fact that the section of the keyway in the shaft and that in the hub are seldom in accurate alignment a certain amount of fitting is usually necessary. In making this special key a tough chisel key is used for the key, which is ground to a size slightly larger than the nominal keyway width. One end of the key is provided with a cutting edge and chip recess. Ahead of the recess is a pilot a little smaller than the keyway so that it fits the latter and guides the key. When installing the key the pilot is entered with the cutting edge on the side and driven home with a hammer or sledge, depending on the size of the key. On the smaller sizes the cutting edge is placed on the one side only but on the larger sizes double cutting edges are used. Special keys with three cutting edges may be obtained if desired. These keys are made in a wide range of sizes and are made by Smith and Serrell, Newark, N. J.

THE OSCILLOSCOPE

With engines or any other machines of large size running at from 50 to 100 revolutions per minute it is a simple matter to observe with the naked eye any irregularity of working that may tend to impair the efficiency, but in modern machinery where speeds of thousands of revolutions are made, undue vibrations or variations in the running cannot be detected.

The optical phenomenon, known as "Persistence of Image" has been utilized in the Elverson Oscilloscope. This is an apparatus for slowing down to the eye any high-speed machinery which it is desired to examine under working conditions. Not only may the machinery under examination be made to appear to be running at apparently one hundredth part of its normal speed, but it also may be made to appear stationary to the naked eye at any point in its cycle of operations, although actually it is moving at its normal speed. It is possible, therefore, to observe any irregularity or vibration which may be taking place and detracting from the efficiency of the plant under investigation, whether it is the finished product or the production of laboratory plant. The oscilloscope deals with all forms of motion, rectilinear, rotary, or cam motions, however intricate, and all problems of vibration, enabling it in the last

(Continued on page 39)



POSSIBILITIES OF THE POWER PLANT ENGINEER

The Editor, Power House:

Will you kindly permit me to make a few comments on the above subject in connection with your article under the above heading in Nov. 20 Power House. It goes without saying that engineers' pay is small on the basis of ability and effort required. But what is the remedy? You suggest organization but not such as is given by the unions. How would organization, such as the doctors have it, serve the purpose? We must not call their organization a union, that is too plebeian a term, but what is the difference between their methods and those of the most autocratic labor union that could be imagined? And they get there.

You mention the C. A. S. E. but do not advise anybody to join it. Possibly this is an oversight, or possibly the printer is to blame, so I will supply the deficiency by advising every engineer to join the C. A. S. E. I am not claiming that the C. A. S. E. is where it ought to be when its age is considered, but you must admit that an association is just what its members make it, almost without exception. Neither am I going to say that the fault has been in the leadership, because the leadership of a good leader may be queered by the efforts of a clique led by an ignorant member of the ward politician type. You are aware, no doubt, that the C. A. S. E. emphasizes education, and that coincides with your idea of what an organization of engineers should do. Not only do we emphasize education but I believe that I am not exaggerating when I say that we are accomplishing something along that line. I think that I can guarantee that a second class engineer can get all that he can carry away (in his head, I mean). More than that, I believe that first class engineers are learning something. It has not always been so however. During my membership in Toronto No. 1, for the past three and a half years, I have found that until recently it was difficult to accomplish anything of an educational nature, many of our meetings reminding me of Kipling's Bandar-log. But that has changed. The members are becoming more interested. There is more pep shown at the educational meetings; more questions are asked and there is more discussion. Not only is more interest taken in the meeting but the association is growing; over twenty engineers have joined since Aug. 1. The advantage of increased membership is being better understood. Increased membership means increased attendance and when the attendance is large enough it can be divided up into classes and graded instruction given, which will be an advantage because there is no doubt that much of the matter that is put on at the meetings is pretty heavy for some members.

To be sure, there are engineers who scoff at anything educational but they will learn their mistake when they try an examination. They will be weeded out and a bunch of them will some day be asking for special consideration because of their length of service—they will not be able to pass the examination.

Again, I advise every engineer to join the C. A. S. E. We are not running an engineer factory but we are helping each other and the stronger we are in numbers the more we can help.

R. McLaren,
160 Dovercourt Road,
Toronto.

* * * *

EVAPORATION LOSSES OF OIL IN TANKS

In a general study of evaporation losses of petroleum being made by the Bureau of Mines, Ludwig Schmidt, junior chemical engineer, has arranged with one of the larger refining companies to conduct a series of tests to determine evaporation losses in 55,000-barrel tanks. Regular monthly gauges will be made and samples of the oil collected in order to determine the change in the quality of the oil during storage. It is later planned to extend this investigation to include water-sealed tanks. Arrangements have been completed for conducting a series of tests in the Tonkwa, Oklahoma, oil field. The crude produced in the Tonkwa field ranges from 42 to 44 gravity and contains approximately 40 per cent. gasoline. Due to the fact that this crude is very volatile the producing companies are anxious to obtain information as to the saving that can be made by the installation of gas-tight tanks. A number of such tanks are already in use in the field, but refining companies are anxious to obtain information as to additional precautions that should be taken in order to reduce evaporation losses.

C. A. S. E. MEETINGS

To the Editor:

In reference to the letter written by Mr. Brown published in the "Power House" on the 5th inst.

He outlines the good work offered by the C. A. S. E. for the benefit of its members, he also criticises many for not taking advantage of the same by failing to attend its meetings, but there are one class of men he fails to mention, namely, those employed of a night. For these members to attend the meetings would mean considerable expense to them, as many would have to forfeit the night's pay, also it would not always be convenient for them to be relieved of their duties. Would Mr. Brown explain how these men are to obtain some of these benefits.

I would suggest that some well-informed member, explain how these men could attend some of the lectures on engineering given in the day time at some of our technical schools and colleges without them having to enroll as regular students.

Also if some of the members of the C. A. S. E. whose name appears in articles published in outside papers would use the "Power House" as their mouthpiece for their views it would receive much more appreciation, also criticism by their fellow members.

I would like to hear some other members' opinions of the same subject.

E. H. Perkins.

Quebec, Que.—There has been considerable activity in the pulp and paper industry in Canada lately. Michigan interests are negotiating with Kingston, Ont., with the view of building there a pulp and paper mill. The Premier Paper and Power Co., of Hartville, N. S., is about to instal a standard newsprint machine with a capacity of 15,000 tons a year. The average daily production of the Abitibi Power and Paper Co.'s plant during August was 462 tons, and on the 29th of the month it reached as high as 494 tons. The groundwood pulp mill of the Backus Brooks Company, near Kenora, Ont., is also well under way. Work has started on the new 13,000 000 plant of the Wigwam Pulp and Paper Company, at Elko, British Columbia.

OUR QUESTION BOX

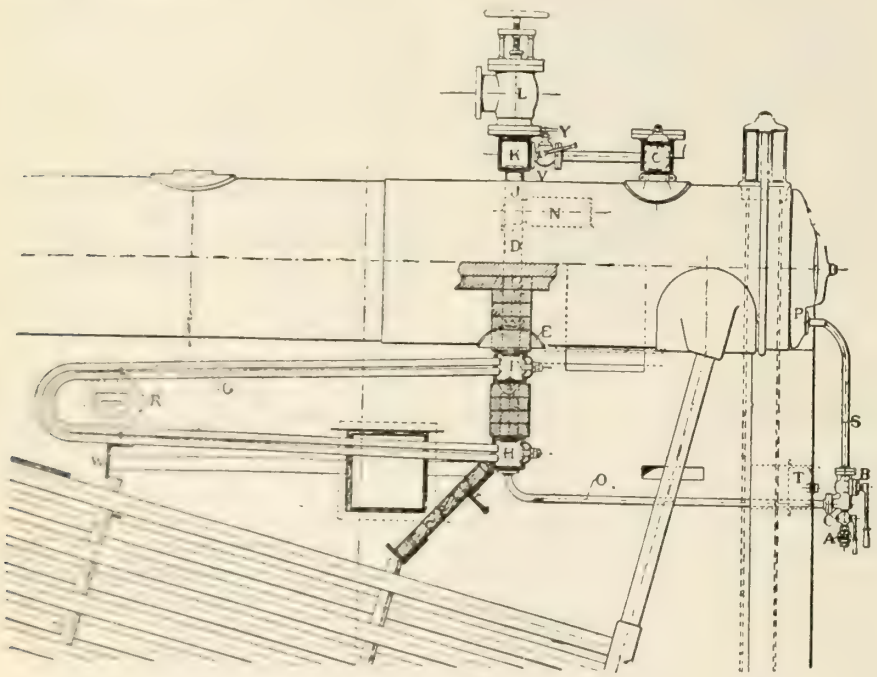
Questions are invited from readers regarding power plant operation and difficulties encountered

FLOODING SUPERHEATERS

Question:—Will you please answer the following question through the next issue of Power House:

What connections are necessary to operate a superheater flooded; also what extra precautions are necessary to follow when changing from and to superheated or flooded conditions; water tube boilers, b. h. p.?—H. E. I. G.

Answer:—We do not know the arrangement of piping and fittings you have in connection with your superheater, which we presume to be a B. & W. type. It might therefore be advisable to fully describe this apparatus with a sketch.



The Babcock & Wilcox Patent Steam Superheater (Fig. 1) consists of a solid-drawn steel tube bent into U shape, and connected at both ends with boxes or manifolds (F and H), one of which (F) receives the natural steam from the boiler through the draw pipe (N) and inlet pipes (D). The other (H) receives the superheated steam after it has traversed the superheater tubes (G) delivering it through pipes (J) and cross-box (K) to the stop valve (L) placed above the cross-box. Handholes are placed in the manifolds opposite the ends of the superheater tubes to facilitate inspection.

The flooding arrangement consists in a connection with the water space of the boiler drum; by means of the larger of two cocks (B) and connecting pipe (S) water can enter the lower manifold (H) and fill the superheater to the water level of the boiler. Any steam formed in the superheater tubes is returned into the boiler drum, through the collecting pipes (D), which, when the superheater is at work, convey saturated or natural steam into the upper manifold (F). Prior to opening the stop valve (L) when a superheater has been flooded, the water is drained away from the manifolds of the pipe (O) and the smaller cock (C). A sight glass (A) is attached to the outlet of the small cock to show when all the water has been blown out. The superheater is placed in a position where there is practically no deteriorating condensation of the gases, and where the temperature is sufficiently high to ensure the steam receiving from 100 to 150 degs. Fahr. of superheat. It is not subject to the immediate action of the fire, as the furnace gases must first pass through the front part of the boiler, which comprises a considerable heating surface. Assuming the boiler to be in regular work, and the firing even, no great fluctuation in temperature can take place where the superheater is fixed. It is readily accessible for examination, and for the renewal of tubes. There are no flanged joints, all the tube joints are expanded. Expansion is provided for by the tubes being free at one end, and by the manifolds not being rigidly connected with each other. Prevention against overheating during steam raising from cold water after cleaning, etc., is ensured by the arrangement for flooding with boiling water, and using the superheater as part of the boiler-heating surface.

* * * *

NUMBER OF LAMPS

Question: I would like to know how many lamps of 100 watts, or how many of 60 watts, could be carried on a circuit the switch of which can carry 50 amps at 110 volts?

Answer: A 100 watt lamp at 110 volts takes practically one ampere. You could therefore carry between 50 and 55 lamps of 100 watt. A 60 watt lamp at 110 volts takes about one half ampere so you could carry approximately 100 lamps of this size on the circuit.

* * * *

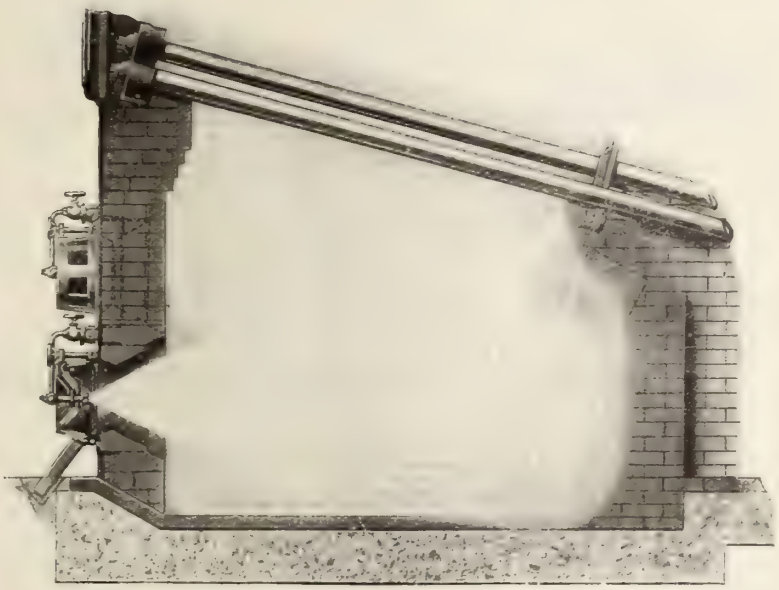
DIGEST

It is obvious to the constant reader of a good engineering journal that a great many ingenious ideas have been thought out and described through the correspondence section. Many of these ideas would be of considerable value if the idea suggested was developed and perfected by some experienced and skilled mechanic. I have seen sketches and read descriptions of home-made equipment, in this section of the journals, which to my mind would be anything but satisfactory in actual use, but on the other hand, perhaps others have seen defects in some of the ideas I have submitted, which looked quite in order to myself.

Simple home-made contrivances can be used with little loss and no great objection, but these could never be compared with the commercial apparatus that is designed for efficiency and some special purpose, such as water-heaters, oil filters, etc. Often an engineer will fail to persuade his employer to buy some piece of apparatus which the engineer is convinced will lower costs, lessen labor, and increase efficiency. As a last resort he attempts to set up a device of his own make, in an endeav-

(Continued on page 39)

BABCOCK & WILCOX
OIL BURNING EQUIPMENT



Babcock & Wilcox furnace for burning oil fuel only

The merits of oil as a fuel for steam generation, in places where its cost compares favorably with coal or wood, are, briefly, the following:—

1. An increase in boiler efficiency, owing to the clean condition in which the boiler heating surface can be maintained, and the completeness of combustion obtainable with a good system of oil firing.
2. A constant and equal distribution of heat in the furnace, and, as there are no fire doors to be opened, the cooling effect of a large volume of air passing over the furnace is avoided.
3. A reduction in the cost of handling the fuel, as this can be done by a pump; and a large reduction in manual labor, the firemen not being required as they would be for ordinary fuels. One man can regulate the burners of a considerable number of boilers.
4. No wear and tear of grate bars.
5. No dust, no ashes, and no clinker.
6. When once arrangements have been made, the storage of oil fuel is simpler than the storage of coal, and oil does not deteriorate.
7. The control of the steam production is easier, more effective and more rapid than with solid fuels.
8. Instantaneous ignition, and extinction of the fire.
9. No smoke.

The three main systems for burning oil fuel are: —

1. That in which STEAM is used as a spraying or atomizing agent.
2. That in which AIR is used for this purpose.
3. That in which the oil is atomized mechanically by PRESSURE.

We would be glad to go into details with a prospective purchaser.

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The Operators' Point of View

BOILER HEAD DEFECT

W. McGheen

An engineer noticed a spray flowing out through the iron on the near head of the boiler, a close examination with pressure off failed to show any flaw, the spot was marked while the boiler was under pressure and later a hole was drilled and properly plugged at the marked spot. This cured the defect, there was no sign of pitting or grooving, the conclusion arrived at was the probability that a small piece of foreign matter had been left in the plate at the point where the blowing occurred, it is difficult to imagine any other cause. This engineer had constant trouble with the burning of the rear hand hole bolt, after the hole had been plugged this trouble was greatly lessened, probably the moisture from the spray had much to do with the burning, this is a tip to others who may be having burned bolt trouble. It pays to examine hand hole plates carefully while the boiler is under test pressure, and make sure the joint is absolutely tight. Some time ago, I was looking over a boiler, the pressure carried was 95 pounds gauge, the 2½-inch blow-off was ordinary weight iron pipe. The man in charge said he had been using this kind of pipe for years and never had an accident, he is lucky. Nothing less than extra heavy pipe should be used for this kind of work, the person who does not know this fact should not be allowed any authority in a boiler room. Besides using heavy pipe, precaution should be taken to protect the pipe to some extent from the intense heat by using a good cover. Sometimes using an asbestos covering on the rear hand hole plate bolt will protect it to a large extent during a monthly run. Such bolts on the ordinary steam boiler are not expensive and it is good business to use a new one each clean out time, usually once a month.

BOILER FEED

By Crippen

I believe it is a good idea to provide two ways by which the water may be fed to steam boilers. To do so, just outside the main feed line from the pump one could put in a tee and run a line from it to the rear end, connecting with the blow-off pipe, and using a cut-off valve and a check valve the same as on the [illegible]. Should one become sediment or scale-choked this extra line can be used until time can be had for making the necessary repairs. Such a pipe may also prove of value to clear the blow-off pipe should it become blocked up, without shutting down the boiler. By closing the valve in the main feed line the full pump pressure can be turned into the blow-off pipe to blow the collected sediment into the boiler, then opening the blow-off valve to get rid of the loosened dirt. It is no uncommon thing for a blow-off pipe to become closed with loose scale when the water contains considerable foreign matter, even when the valve is opened several times during a 24 hour run. The instructions may be to open the blow-off valve every few hours but instructions are often not adhered to. It means a big expense, to say nothing about the annoyance, when a fire has to be drawn and pressure lowered to clear a blow-off. The steam boiler in a power plant is a mighty important piece of apparatus and often receives little attention so long as things appear to be going along O. K. A boiler to generate the greatest amount of steam from the smallest amount of fuel must receive very careful attention as to cleaning internally and externally, time allowed for cooling and steam raising, etc. Of course, the large concerns usually have enough boilers so that one or two can be taken off at a time and the proper time allowed for cooling and cleaning, but a great many of the smaller plants have no such ideal condition. The result is the boilers are apt to get some severe abuse. When this happens it is not well to always lay the blame of ill-used boilers upon the engineer, often he is compelled to do as he is told or to look for another position. A man with a wife and young ones to support will hesitate to throw up a situation, for often it is by no means easy to find a new one.

ONTARIO STEAM BOILER ACT

A joint deputation from the Canadian Association of Stationary Engineers and the International Union of Steam and Operating Engineers interviewed by appointment officials of the Ontario Government with reference to suggested improvements in the Steam Boiler Act. The Government officials present were Mr. J. H. H. Ballantyne, deputy minister of labor; Mr. Burke, chief inspector of factories and Mr. J. M. Brown, chief examiner of engineers. The deputation urged on the deputy minister the necessity of bringing all boiler inspection under one department, and also the appointment of more inspectors under the Board of Examiners so that the law with regard to certificates could be more fully enforced.

The deputy minister listened courteously to the deputation and promised that their requests would be given consideration.

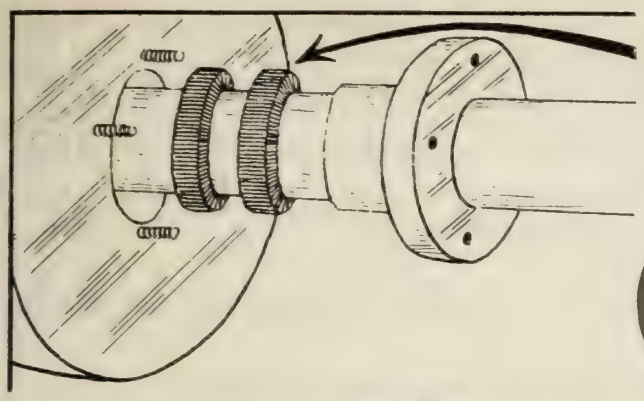
PISTOL-GRIP HACKSAW FRAME

A pistol-grip hacksaw frame has recently been offered to the trade. Springs are used to provide constant tension on the blade. This feature enables the blades to be changed quickly. The adjusting pawl is set down inside the frame as low as possible. Strong but light steel tubing is used for the back and all steel parts are nickel-plated. The blade may be set to cut in any one of four directions by means of the wing nut. The frame is 3⅜in. deep and blades of from 8 to 12in. may be used. The hard rubber, checked handle provides plenty of finger room and gives a comfortable grip for the operator. These frames are made by the L. S. Starrett Co., Athol, Mass.

Pistol-grip Hacksaw Frame.

ELEVATOR LUBRICATION

The problem of lubrication of elevator machinery is becoming of considerable importance to the engineering profession to-day. The ever-increasing demand for elevator service, as higher buildings are becoming more and more necessary to house the executive offices of our industries and store their products, has eliminated the heretofore popular idea that elevator machinery, especially of the electric type, could be lubricated in much the same manner as other types of gearing and general motor driving mechanisms. There are certain pertinent operating features which prevail that demand considerable cooperation between the elevator engineer and lubricating oil manufacturers, and careful attention must be paid to these details.



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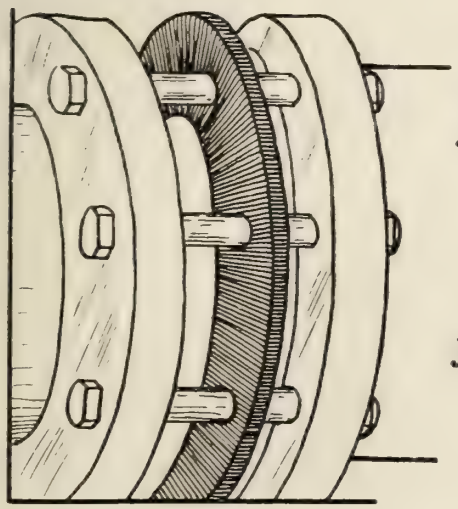

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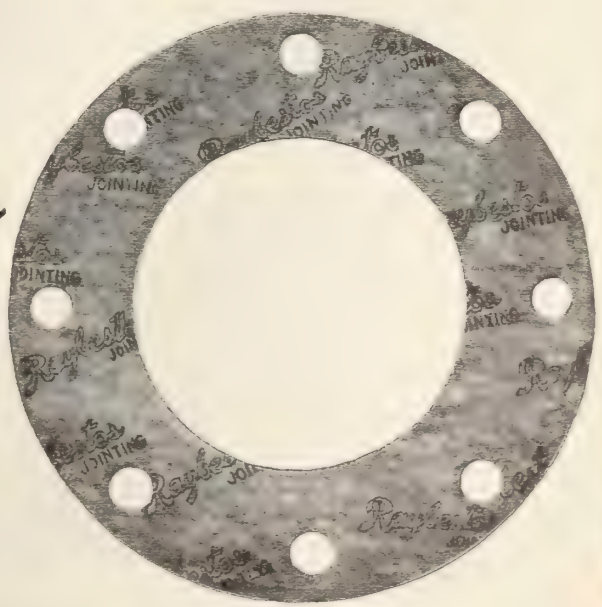

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PULVERIZED FUEL HANDLED BY COMPRESSED AIR

Some further details regarding the equipment to be used in handling the pulverized coal at the New Cahokia Station of the Union Electric Light & Power Company, St. Louis, Mo., have been announced.

Among these, the method of weighing the fuel and conveying it from the pulverizers to the boilers is of unusual interest. Below the floor level of the pulverizing room will be placed a series of five blowing tanks, which serve an equal number of twin pulverizing units. These blowing tanks will rest on platform scales, the dial of which will indicate to the operator in the pulverizing room the amount of fuel in the tank.

The fuel will feed into these tanks by gravity, as desired, from the pulverized fuel bins in the pulverizing room. Each charge will be automatically weighed, and then elevated about 75 feet, by compressed air, through 4-inch pipes. A simple system of switching valves and parallel distributing mains, cross connected, enables any blowing unit to be discharged into any of the eight enclosed storage hoppers in the boiler house. These hoppers serve the four pairs of boilers, each of 1,780 h.p., comprising the first group of boiler units to be install-

The fuel requirements for the first group of units are estimated at 1,000 tons in sixteen hours. This equipment was selected on account of its cleanliness and freedom from mechanical complications which would be liable to interrupt service. The contract has been awarded to Quigley Fuel Systems, Inc., of New York.

BELT SPEED

Belt speed is determined by the rim velocity of either the driving or the driven pulley. It is equal to the diameter of the pulley times 3.1416 times the revolutions per minute of the pulley. If the pulley diameter is given in inches, divide the answer by twelve to get the speed in ft. per min. Example: 14 in. dia. pulley running 600 r.p.m.

$$\frac{14 \times 3.1416 \times 600}{12} = 1675 \text{ f. p. m.}$$

Avoid crossed belts on short center distances. Avoid crossing wide belts anywhere. If crossing is necessary, see that the rubbing of the belt surface does not have a tendency to open up the laps.

Use a wide enough pulley so a small amount of belt irregularity does not make it run off. Allow at least ½ inch on machine pulleys, and 1 inch or more on countershaft and lineshaft pulleys. Use crowned pulleys where possible.

If possible, use a horizontal belt with large center distances and the pulling side at the bottom. In a horizontal drive, the slack side of the belt at the top of the drive increases the belt contact.

To obtain a given amount of power, better use a narrow belt running at high speed than a wide belt at low speed.

Where possible, use a belt speed of 3,000 ft. per minute, but no more than 3,600 ft. per minute.

Smart-Turner Machine Co., Hamilton, report the following recent sales: Two No. 4 double suction centrifugal pumps for the Abso-Pure Ice Co., Hamilton, few small triplex power pumps, ordered by Department of Marines & Fisheries, for delivery to the Dominion Lighthouse Depot, Prescott. A No. 4 belt-driven centrifugal pump, ordered by H. F. Routley, Toronto, for quarry service near Caledonia; one 4½ x 2¾ x 4 duplex, packed-piston pump, to Standard Paving Co., Lindsay; a pair of 8 x 10 x 12 simplex vacuum pumps; an automatic feed pump and receiver equipment with motor-driven centrifugal pump and two motor-driven centrifugal circulating pumps for the Essondale Asylum, Vancouver, B. C., and a 5½ x 6 triplex power pump for Vipond-North Thompson Mines, Timmins, Ont.

SUPERHEATERS

ELESCO

DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

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TENSION AND WORKING STRAINS

(Continued from page 30)

slack strand 60 pounds in order to give the necessary 60 pounds of pulling power, and the bearing must stand a load of 180 pounds, just twice the load in the other case noted above.

The maximum load on the fastener in each case is the tension of the tight strand of the belt. In the extreme case of the poor belt described, the fastener would have to withstand 120 pounds per inch of width. Efficient belt hooks under many tests, have shown a strength never less than 400 pounds per inch of belt width and it is easy to understand why they carry the full belt load and do not put out. Even in a poor belt carrying its rated load (which as a matter of fact is not possible with such a poor belt) there is a margin of safety of 400-120 or 280 pounds.

In the chart the length of the bars represents the total strength of efficient belt lacing in a one-inch belt. The black area shows the proportion of this which is actually required to transmit the rated horse power to the belt, while the white area shows the margin of strength remaining as a safety factor.

THE OSCILLOSCOPE

(Continued from page 32)

case to show the periodicity with regard to any shaft at once, and without calculation, and in the case of compound vibration to analyse it into its component constituents and resolve those constituents in such a way as to determine at once their origin and frequency.

The advantages of such a machine says "Steam," are only too apparent and it may be that it will give the same information regarding the variations of stresses in machines as the indicator gave of the working and variations of pressure of steam in an engine cylinder.

This machine is now being demonstrated by Messrs. H. Kennedy & Co., 46 Gordon St., Glasgow.

DIGEST

(Continued from page 34)

or to show better results or to influence his employer to purchase the factory-made article.

Perhaps there would not be so many defects in home-made equipment for power plant use if the experimenters were familiar with the latest improved appliances on the market. There is no excuse for any engineer to be ignorant of such knowledge. All he has to do is to systematically read his engineering journal, especially the advertisements. If he does not, there will be many important improved apparatus which he may never hear about.

There are many engineers who value their classified files of clippings taken from the advertisements equally as much as technical matter taken from their text-books.

James Noble.

Calgary, Alta.—With oil developments in Northern Montana now being undertaken on a wide scale, various American companies are taking steps to secure extensive leases on the Canadian side of the line. One concern has obtained 31,000 acres in Southern Alberta, and others are considering the leasing of other substantial acreages.

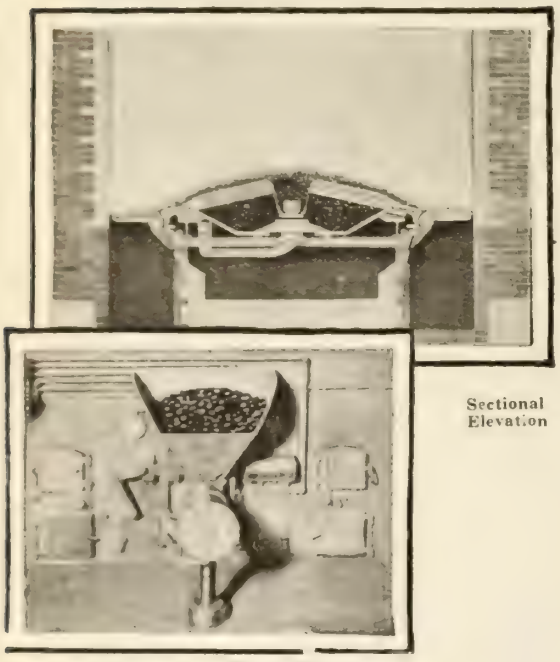
PLAN TO EQUALIZE AIR PRESSURE

When large quantities of air are used underground, it often happens that there are wide fluctuations in the amount needed at any one time. A plan to keep the pressure uniform and to provide additional storage is in use at a plant near Bisbee, Ariz. At the top of the hill, which is about 200 feet high, is a reservoir. Into the bottom of this a large pipe is connected, which follows the contour of the hill down to the base, where the air receivers are situated. This pipe acts as an auxiliary receiver. Under conditions of small air reserve it is filled with water. If the amount of air on hand increases, the water is forced up the pipe and into the reservoir. When greater demands are made on the available supply of air, the water falls in the pipe and so keeps the pressure uniform.

In developing hydro-electric power on the Oswegatchie River in northern New York a wood-stave pipe is being constructed twelve feet in diameter and more than two-thirds of a mile long. The staves are of Douglas fir brought from the State of Washington. They are 3½ inches thick and are able to sustain a head of water of 140 feet.

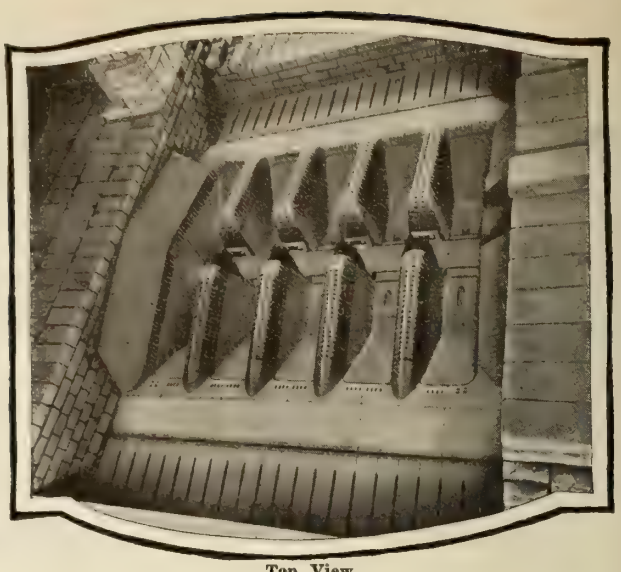
The Imperial Oil Co. has just completed two large storage tanks at Sydney, N. S. This will form part of the plant now being erected. These tanks have a capacity of 10,000 gallons each.

The Coal is Underfed from Start to Finish



Sectional Elevation

Front View



Top View

AS A RESULT of the revolutionary *"lateral retort"* principle the advantage of the multiple retort stoker—high capacity and efficiency—are combined with the advantages of the side-cleaning stoker—lower first cost, reduced installation cost, and adaptability to old boilers.

The *"Lateral Retort"* Stoker is not claimed to be a substitute for multiple retort stokers—but—it does bring the advantages of multiple retort stoking to the plant that otherwise would install an inferior stoker.

The illustrations, opposite show how the truly underfeed effect is accomplished. The coal is first underfed into the central retort by means of a main ram. It is then underfed—always underfed—into the *"lateral retorts"* by means of an auxiliary steam cylinder which operates lateral pusher rods.

There is only one simple unit for distributing fuel in five or more *"lateral retorts"* and, since this feeding mechanism is controlled independently of the main fuel feed, ideal distribution is possible under all conditions.

A trench 16 to 18 inches below the floor line is sufficient excavation for ash pits. This reduces installation cost and makes the stoker adaptable to boilers already in service. The many good points of this stoker are covered in greater detail by a new bulletin. Where shall we send it?

The "LATERAL RETORT" STOKER

Under-feed Stoker Co. of Canada Ltd.
146 King Street West, Toronto

Sales Agents for Jones Under-Feed Stokers, Riley Under-Feed Stokers, and Murphy Automatic Furnaces

Alta. and West Sask.:
Mr. J. Twomey,
[illegible]

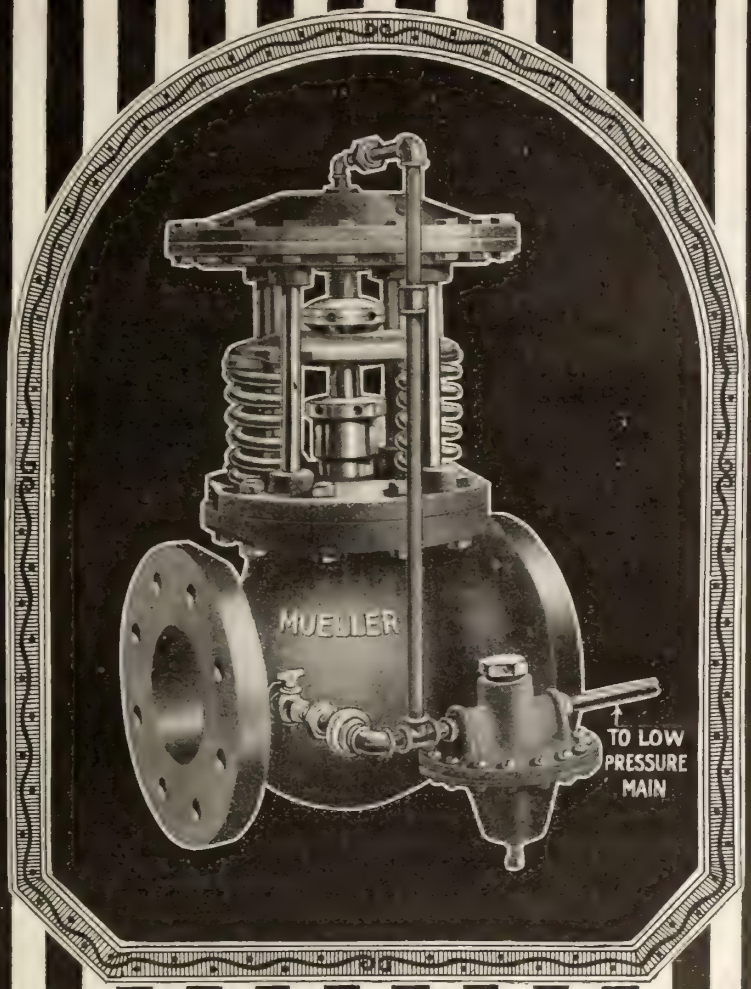
Man. and East Sask.:
A. W. [illegible] & Co.,
[illegible]

British Columbia:
E. A. Earle, Limited,
Vancouver, B.C.

Quebec
The Cleaton Co., (Canada) Ltd,. Montreal, Que.

Known by this sign

RILEY JONES
The UNDER-FEED STOKER COMPANY OF CANADA LTD.
MURPHY



Constant Delivery Pressure

Mueller Reducing and Regulating Valve A-5030 is specially constructed for use on exacting installations. It will reduce as desired and deliver at a uniform pressure regardless of variations in initial pressure. It is a single seat, auxiliary operated valve for water, gas and air and is made in sizes from 1¼″ to 12″.
Mueller makes valves for all purposes. Write and tell us your problems and we will give you the solution to them.

H. MUELLER MFG. CO., LIMITED, SARNIA, ONT.

Water, Plumbing and Gas Brass Goods and Tools.

American Factory at Decatur, Ill., U. S. A. **Branches, New York and San Francisco**

Mueller Metals Co., Port Huron, Mich., Makers of "Red Tip" Brass Rod, Brass and Copper Tubing, Forgings and Castings in Brass, Bronze and Aluminum; also Screw Machined Products.

ANNOUNCEMENT

You are no doubt familiar with the famous "Flame Brand" line of High Temperature Cement. We are pleased to announce that we have secured the Canadian agency of this extensive line and are prepared to guarantee quality and service on all orders. Some of the leading "Flame Brands" include·

Blue Flame Fire Brick Cement
Red Flame Plastic Cement
White Flame Insulating Cement
"Mono" Boiler Baffling
High Grade Fire Brick

Write today for literature telling the whole story

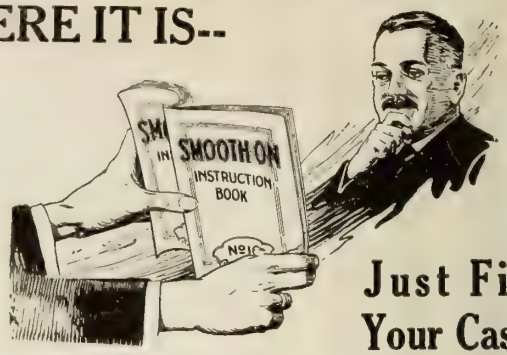
Prompt Service

GRANT E. COLE CO.

21 River Street, TORONTO

SMOOTH-ON IRON-CEMENTS

HERE IT IS--



Just Fits Your Case!

Many engineers have learned from experience not to say, "That will have to come down for repairs," until after they have tried Smooth-On Iron Cements. For Smooth-On saves dismantling in a large proportion of cases.

S M O O T H - O N
Instruction Book No. 19

just off the press, contains 144 pages of engineering information and shows many instances of how time and money were saved by engineers through the use of Smooth-On Iron Cements for making power plant repairs. This book shows you "how it is done"—quickly and economically—without dismantling machinery or pipe lines. Write today for your copy—IT'S FREE.

Smooth-On Iron Cements are sold in 5-lb., 10-lb., and 25-lb. tins; also in larger sizes.

THE CANADIAN ASBESTOS CO.,
Dept. 52-L, 36-48 Youville Sq., Montreal, Que.
If your supply house cannot supply you, write us direct.

JOINTLESS PLIBRICO
FURNACE LINING

For BAFFLES

In actual service Jointless PLIBRICO, the time-tested plastic fire brick, has proved the ideal material for baffles and complete furnace linings. It forms a smooth, monolithic baffle that fits snugly around the tubes and resists temperatures to 3,100° F. There are no tile to crumble and spawl, so PLIBRICO baffles last longer while giving better service. Ask for our special leaflet, etc., on Baffles.

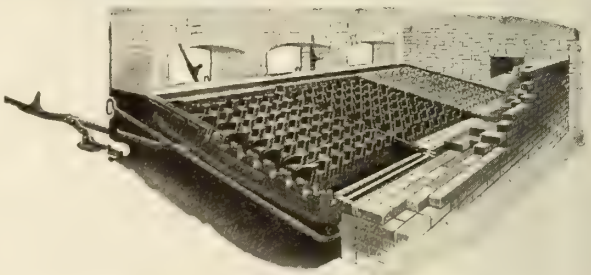
BEVERIDGE SUPPLY CO., LTD.

628-630 St. Paul St. West,
MONTREAL

Stocked also in Toronto, Winnipeg, Calgary and Vancouver

CoKal 'Chainless' Stokers

Self Cleaning *Hand Operated*



CoKal stokers can be furnished with or without hopper feeds

EASY TO OPERATE
INCREASE CAPACITY
ELIMINATE SMOKE
HIGH RATINGS
INCREASE EFFICIENCY
COST REASONABLE
SAVE COAL
INCREASE EVAPORATION
GUARANTEE RESULTS
UNIFORM FIRE BED
FIRES ALWAYS CLEAN
SOLVE BOILER PROBLEMS

The Best Hand Stoker Built

GELINAS & PENNOCK Reg'd.

207 St. James Street, Montreal, Canada

BAILEY Fluid Meters

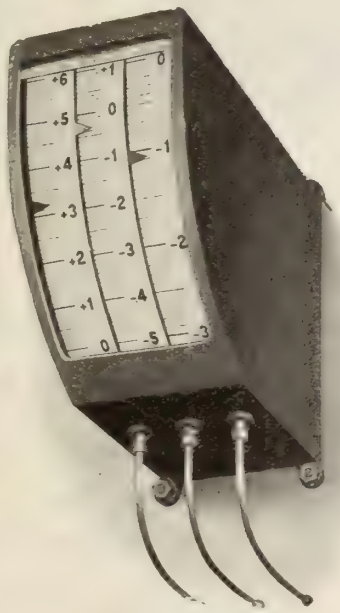
Unless you know exactly how much steam you are using to heat your plant—unless you are able to keep comparative records — how can you know how near to the standard of practical operating efficiency your daily steam consumption approaches?

The Bailey Fluid Meter will give you all the information required for this check. It will indicate—and record for future reference — record and integrate Steam Flow, high or low pressure, with accuracy and with practically no attention.

The Bailey Fluid Meter is self-contained, portable and is made with capacity to suit each particular installation. It records rate of flow in any desired units on 12-inch, 24-hour, uniformly graduated charts. IT WILL SAVE ENOUGH IN A SHORT TIME TO PAY THE COST OF INSTALLATION.

BAILEY Multi-Pointer Gauges

Can be equipped with separate pointers to indicate scale readings of practically every factor of operation. Each pointer has a 10-inch motion over illuminated scale, graduated so that readings can be made at a distance of 20 feet.



All Bailey Products are made in Canada

Write for Bulletins

Bailey Meter Company Limited

177 Delorimier Ave., Montreal, Que.

Use Logic in Buying Your Babbitt Metal

Protection from power waste, hot boxes and complete bearing breakdowns involves no particular increase in initial cost if you line your bearings with Magnolia Anti-Friction Metal, but you would effect a substantial ultimate saving, to say nothing of the more dependable service and relief from bearing worries.

If your supply man offers a substitute, write us direct.

Magnolia Metal Company

113 Bank St., New York.

Chicago Fisher Bldg. | San Francisco Pacific Bldg. | Montreal 87 Shannon St.

MAGNOLIA ANTI-FRICTION METAL

TRADE MARK

A COMPLETE SERVICE IN

"John Crane"

FLEXIBLE METALLIC PACKING

STYLE 601—CONDENSER TUBE PACKING.

Now Available

"John Crane" Metallic Packing for condenser tubes (patented) is now available for immediate delivery.

This process has won enormous favor in marine service and in installations of a large number of stationary condensers.

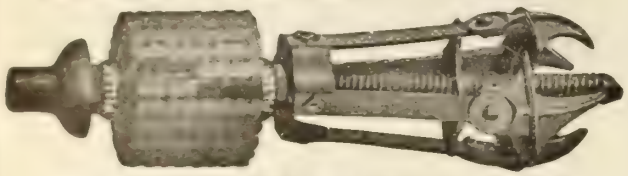
Positively renders condensers leakproof and saves tubes from destructive stress and corrosion. Our very interesting text book on this subject sent on request.

FLEXIBLE METALLIC PACKING CO.

WINDSOR, ONTARIO, CANADA.
BELDAM'S ASBESTOS PACKING & GENERAL MFG. Company Limited, Toronto and Montreal.
H. E. CARMAN, 334 Cordova St., Vancouver, B.C.
"MADE IN CANADA"

HINTS TO BUYERS

The Simplest and best cleaner on the market is

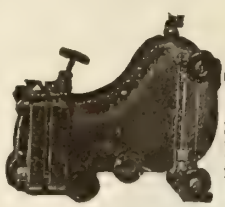


PILLEY'S

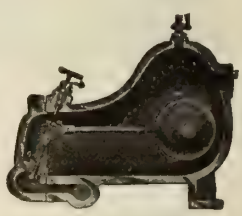
Combination Flue Brush and Scraper.
Guaranteed not to break or the wires to pull out or lay over. A simple turn of the hand adjusts it to the tube, and the brush removes what the scraper loosens.
For sale by leading Canadian jobbers.
Manufactured by
PILLEY PACKING AND FLUE BRUSH MFG. CO.
623 South Third Street - - - St. Louis, Mo.
Eastern Office: 71 Fulton St., New York.

Make Good With
Your Product
and Then
Advertising Can
Make Good for You

ELK FIRE BRICK
Coupled with
OUR SPECIAL SERVICE MEANS ECONOMY
Let us know your requirements. We will solve the problem.
Write us Today
Elk Firebrick Co. of Canada, Ltd.
Sun Life Building, Hamilton, Ont.



McDaniel Improved
STEAM TRAP
FOR HIGH OR LOW PRESSURE
Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.
May We Send One for Trial?
Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.
Send for Catalogue
THE GARTH COMPANY
1 Craig Street - MONTREAL, CAN.
WATSON & McDANIEL CO.
No. 146 N. 7th St., PHILADELPHIA, Pa.



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for
HEATING and POWER PLANTS
Correspondence Invited
ENGINEERING & CONTRACTING
The T. J. CUNERTY Company
Room 240 17 Queen St. East Toronto

"Pop Off" Steam
Carries Ashes Away

"Into the hole and away they go" describes ash removal with a Green Steam Jet System. At the Kewanee Boiler Co., they use "Pop off" waste steam to do the work.
Write to Dept. X for descriptive literature.

GREEN ENGINEERING COMPANY
175 Kennedy Avenue
EAST CHICAGO INDIANA

Get the Most Out of Your Fuel

THE BOILER D. M. LIFE SAVER

Keeps your boiler clean and thus eliminates repair bills, besides reducing maintenance cost.

Will not injure boilers or fittings.

No acid — No chemicals — Just "D. M."

"D.M." Boiler Compound is a Vegetable composition, absolutely harmless, and will keep your boilers clean right down to the bare metal. Prevents all scale formation, corrosion and pitting. "D.M." Boiler Compound is used by many of the largest users of steam throughout the world including the British Government.

Manufactured by: HOUSEMAN & THOMPSON, Ltd., Newcastle-on-Tyne, England.

Sole Distributor for Canada :

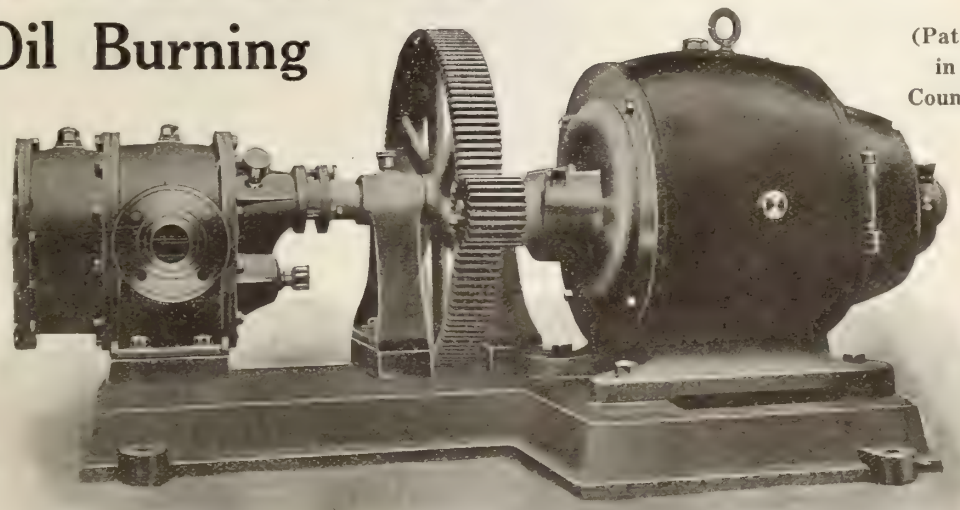
J. A. CARRUTHERS - 23 Scott Street, Toronto

The "ALBANY" Water Sealed ROTARY PUMP

No Valves in These Pumps
Nothing to Get Out of Order

For Fuel-Oil Burning

(Patented in all Countries)



While the "Albany" Patent Rotary Pump is suitable for dealing with gas exhausters, oil, wine, vinegar, brine, acids, spirits, domestic water supplies, etc., it is ideal for fuel-oil burning systems. Made in sizes from 100 to 60,000 gallons per hour.

The "Albany" Water-Sealed Rotary Pump has been approved and used by the British Admiralty for many years. It is favored because of its simplicity, economy and dependability.

Submit your pump problems to us.

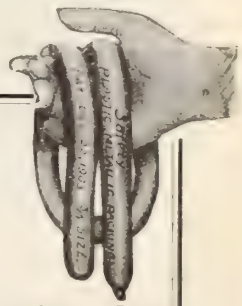
Write to-day

As a Vacuum Pump of its type, it has no equal.

ALBANY PUMP COMPANY

159 Richmond Street W., Toronto, Ont.

"SAFETY" PLASTIC METALLIC PACKING



Packing in Cotton Tubes.

This packing is made of an alloy of the FINEST ANTI-FRICTION METALS which, combined with the BEST LUBRICATING MATERIALS which always remain in the packing, make it practically **Self-Lubricating and Frictionless.** It is

GUARANTEED TO LAST THREE YEARS WITHOUT RENEWAL

In fact there are many Engines, Pumps, Compressors, Expansion Joints, Valves, etc., on which this packing has been in use for over 12 years with the very best satisfaction.

Let us send you further particulars also about our "Safety" Superheat Sheet Packing.

Packing in bulk.

Established 1899

STEEL MILL PACKING CO. - WINDSOR, ONT.

AGENTS WANTED

2

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Study "POWER HOUSE" Advertisements

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D. K. McLaren Limited, Montreal, Que.

CHAIN WHEELS
The Mason Regulator & Eng. Co., Ltd., Montreal

CHAINS, MALLEABLE, DETACHABLE AND RIVETED
Can. Link Belt Co., Toronto, Ont

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Sexton Boiler Setting Co., W. R., Toronto.
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Northern Equipment Co., Erie, Pa.

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The Fisher Governor Co., (Inc,) Marshalltown, Iowa.

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Beveridge Suply Co., Montreal.

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Goldie & McCullough Co., Galt.
Lunkenheimer Co., Cincinnati, Ohio.
Jas. Morrison Brass Mfg. Co., Toronto.
Sexton Boiler Seting Co., W. R., Toronto.

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Babcock & Wilcox, Ltd., Montreal.
Beveridge Supply Co., Montreal.
Can. Johns-Manville Co., Ltd., Toronto.
Can. Mead-Morrison Co., Ltd., Montreal.
Arthur S. Leitch Co., Ltd., Toronto.
Gelinas & Pennock, Reg'd. Montreal.
Lunkenheimer Co., Cincinnati, Ohio.
The Reliance Gauge Column Co., Cleveland,
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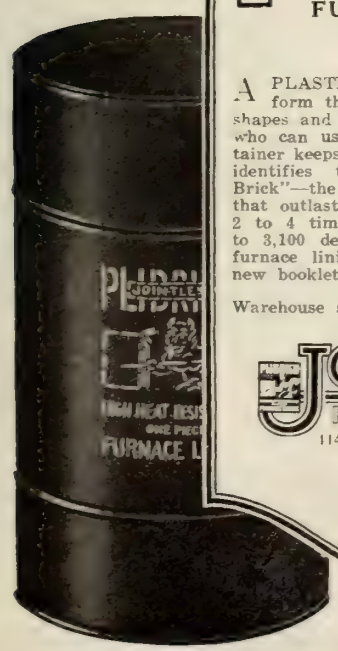

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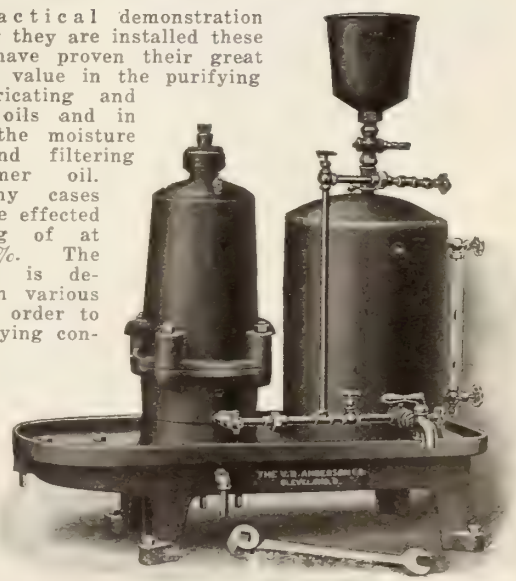

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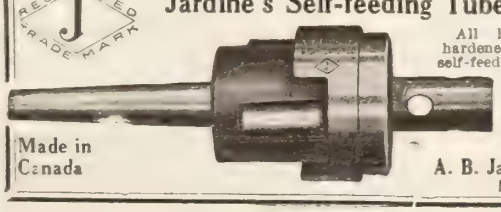
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Jas. Morrison Brass Mfg. Co., Toronto

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Jenckes Bros., Ltd., Montreal
Penberthy Injector Co., Windsor, Ont.
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GENERATORS, STEAM TURBO
& Lamb, Montreal

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Engine Co., Ltd., Hamilton,
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W. R. Sexton Boiler Setting Co., Toronto, Ont.

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Shell Bar Boico Supply, Ltd., Toronto.
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Goldie & McCulloch Co., Galt.
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Babcock & Wilcox, Ltd., Montreal
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Babcock & Wilcox, Ltd., Montreal.
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HOSE, WATER, STEAM AND AIR
Gutta Percha & Rubber, Limited

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The Bailey Meter Co., Cleveland, Ohio.
Can. Johns-Manville Co., Toronto.

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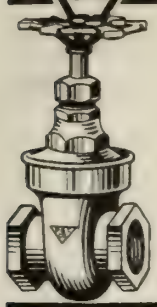

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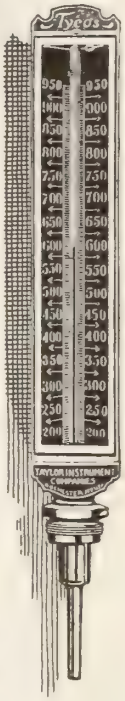

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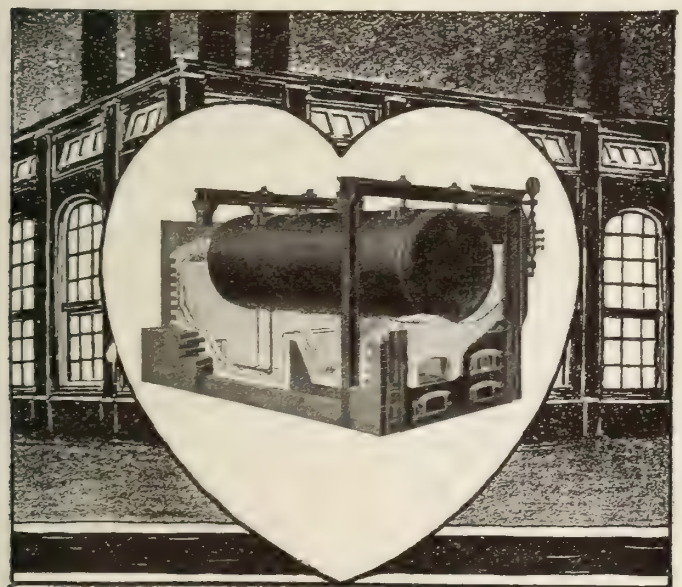

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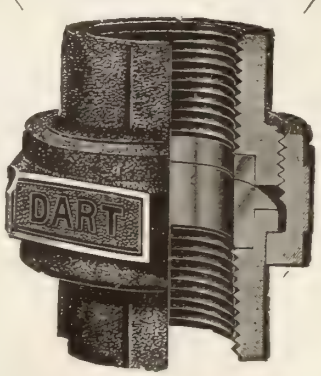

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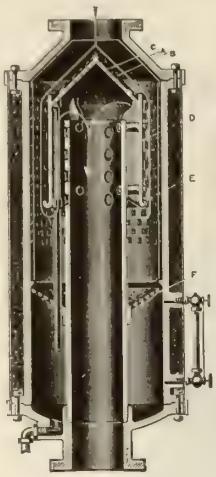

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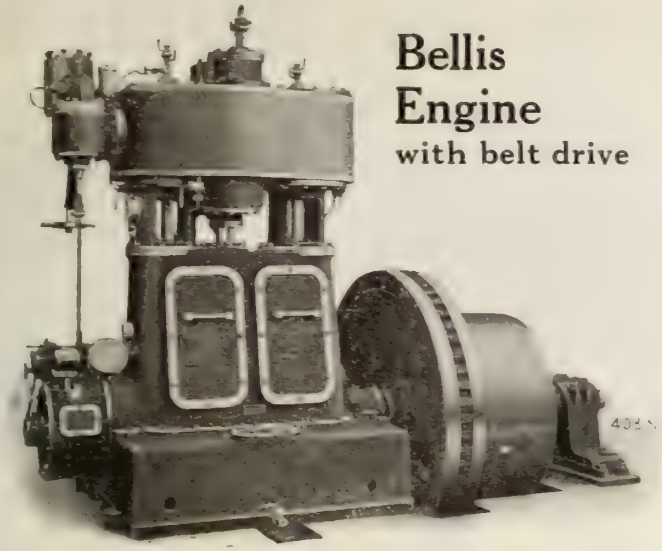

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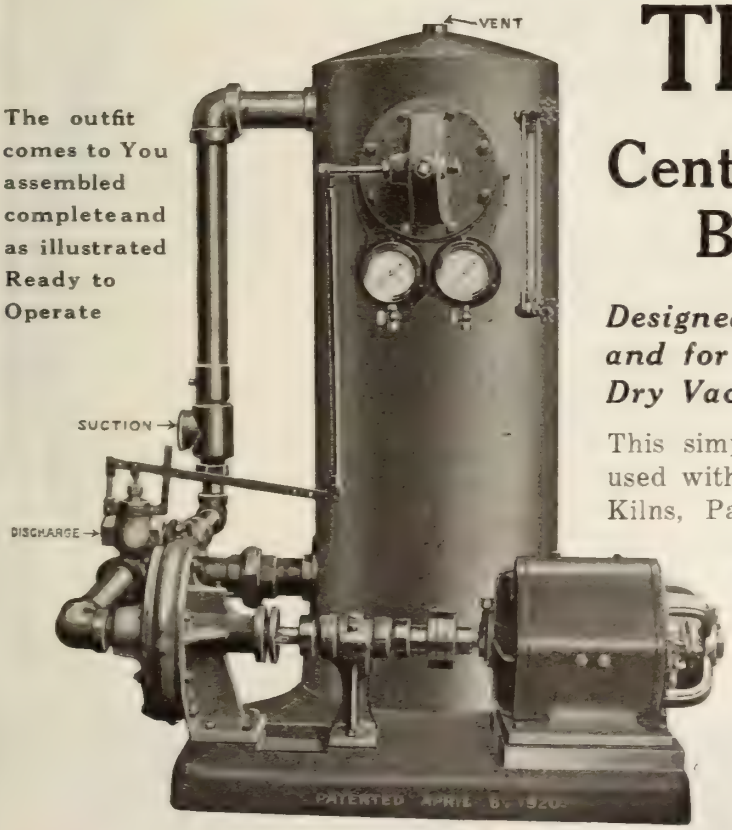

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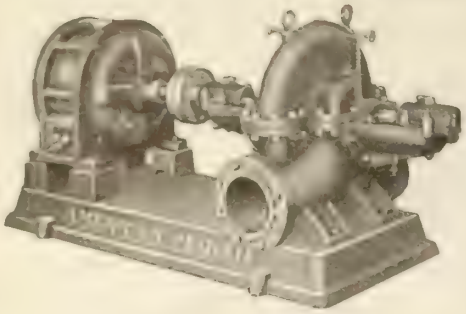

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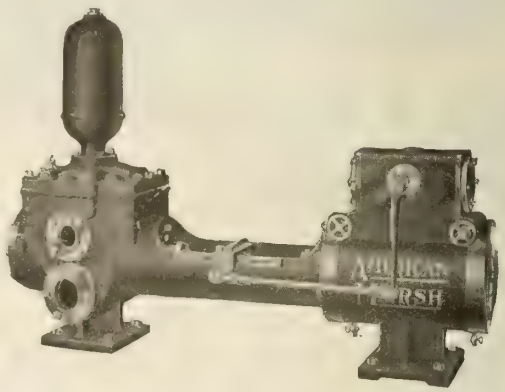

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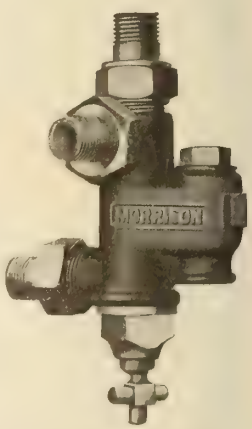

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Fig. 425.
"RELIANCE" REGRINDING VALVE (Sectional View)
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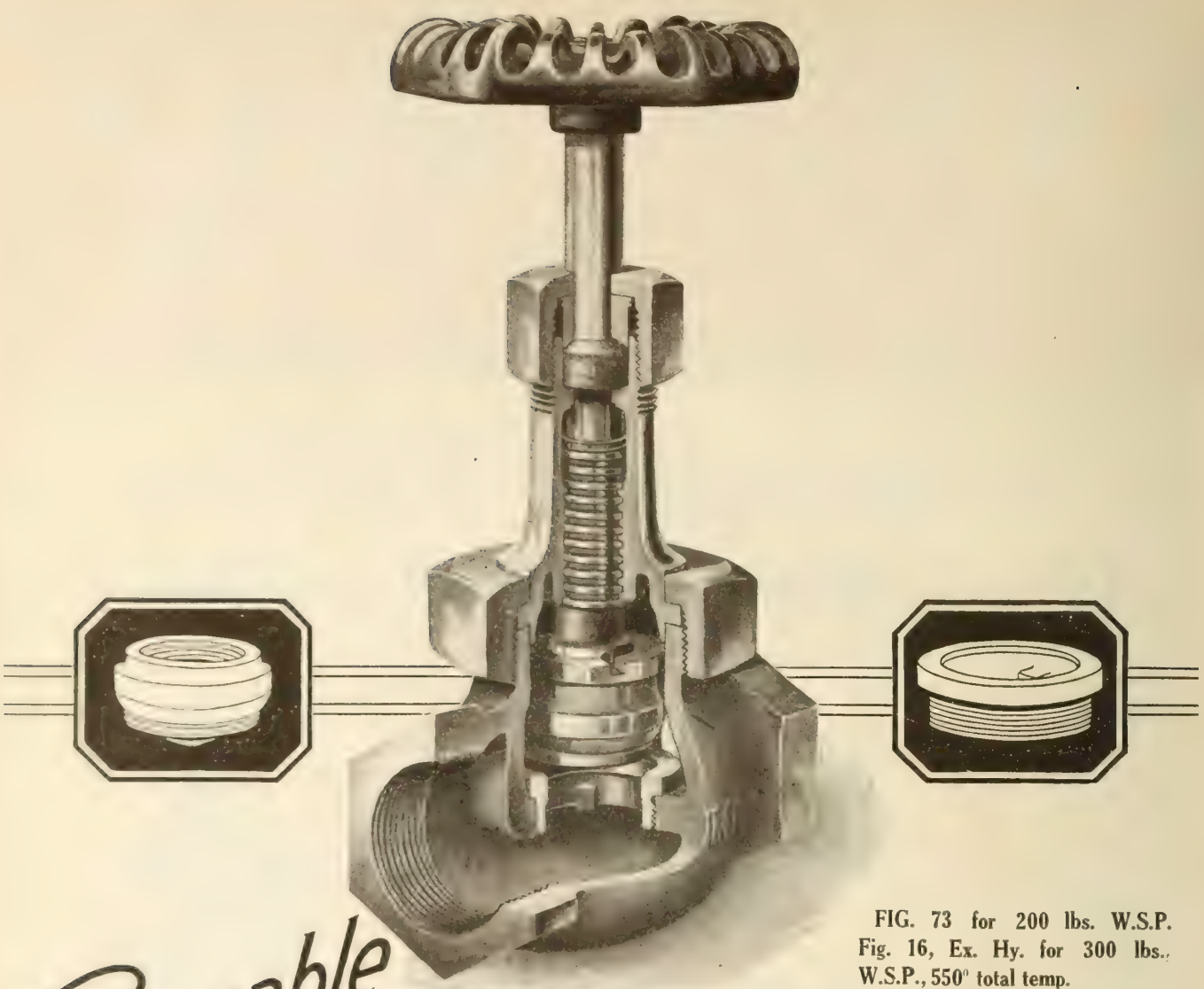

FIG. 73 for 200 lbs. W.S.P.
Fig. 16, Ex. Hy. for 300 lbs. W.S.P., 550° total temp.

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Write for a copy.

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO CINCINNATI, U.S.A. BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

"America's Best since 1862"

The Waterous Engine Works Company

of Brantford, Ontario

cordially extends to its many business friends

Best Wishes

for

A Merry Christmas

and a generous share of the prosperity which
it believes is coming in the New Year

Top view and sectional elevation of *"Lateral Retort"* Stoker.

Underfed throughout

—multiple retort stoking without multiple retort complications

THE *"Lateral Retort"* Stoker has made possible, for the first time, a multiple retort effect in a simple side-cleaning stoker—a stoker that costs far less than a multiple retort stoker; that requires no expensive provisions for installation; that is adaptable to old boilers because no basement space is required for ash pits.

How the ingenious *"lateral retort"* principle insures multiple retort stoking in a simple stoker with only a few rugged moving parts, is shown by the illustration above. The arrows tell the story. Coal is first underfed to the large central retort by a steam driven ram. It is then underfed to the several *"lateral retorts"* by means of simple pusher rods, all of which are operated by a single auxiliary steam cylinder. From its entrance into the main retort until it reaches the dump plate, the coal is always *underfed*—an advantage heretofore possible only in stokers of the multiple retort type.

The *"lateral retort"* arrangement also provides a large fuel capacity for meeting peak loads and overloads. Eighteen inches is sufficient excavation for ash pits and consequently the stoker is ideal for low set boilers.

Learn how the *"Lateral Retort"* Stoker meets a hitherto unfulfilled need. Write for the bulletin.

RILEY JONES

The UNDER-FEED STOKER COMPANY OF CANADA LTD.

MURPHY

Chateau Frontenac, Quebec, is *"Lateral Retort"* equipped.

THE UNDER-FEED STOKER CO. of Canada, Ltd.

146 King Street, West · Toronto

Sales agents for: Jones Stokers, Riley Stokers and Murphy Automatic Furnaces

Alta. and West. Sask.: [illegible]

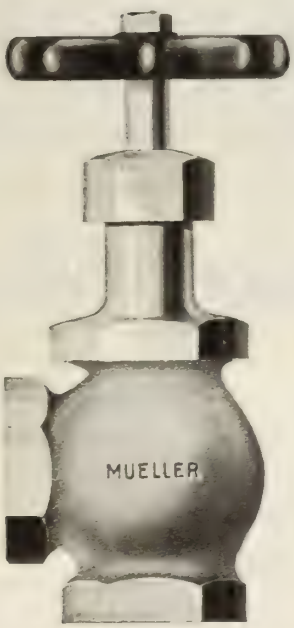
Man. and East. Sask.: W. W. Hicks & Co., Winnipeg

British Columbia: E. A. Earle, Limited, Vancouver, B. C.

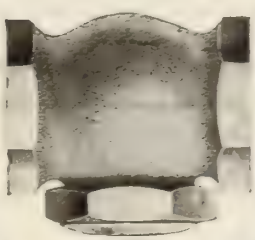
Quebec: The Creator Co. (Canada), Ltd., Montreal, Que.

"The Lateral Retort" Stoker

A-2090



A-2091



A-2092

Valves that set a High Standard

Mueller Valves are not only known as good serviceable valves but invariably set a standard by which other valves are judged.

Positive in action. Designed so that the stem threads are protected by valve bonnet when open. Added strength is given by the inside threaded bonnet.

There is Strength in MUELLER Valves

The Mueller design provides a heavier and stronger valve.

Each valve must prove itself in severe tests before it leaves the factory—a safe, dependable valve in any kind of service.

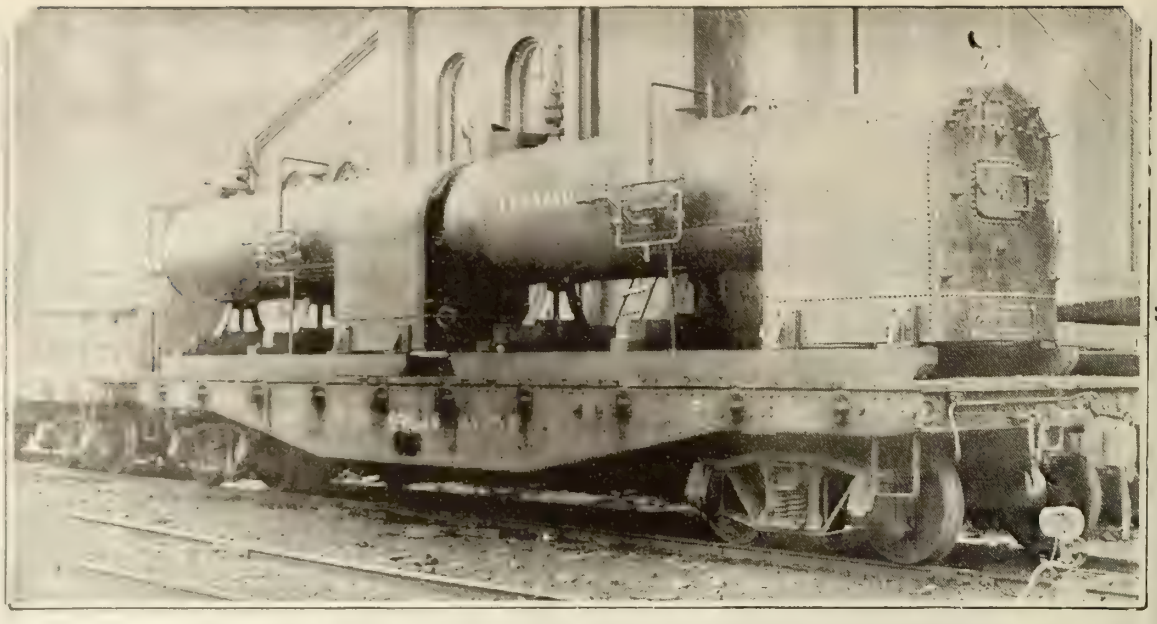
Send for data on the valves in which you are interested.

H. MUELLER MFG CO., LIMITED,
Sarnia, Ont.

Water, Plumbing and Gas Brass Goods and Tools

American Factory
Decatur, Illinois, U.S.A.

Branches,
New York and San Francisco



Two 60 H.P. Locomotive Boilers for 125 lbs. Under Ontario Regulations.

E. LEONARD & SONS, LIMITED
Head Office and Works, London, Canada.
Branches and Agents from Coast to Coast.

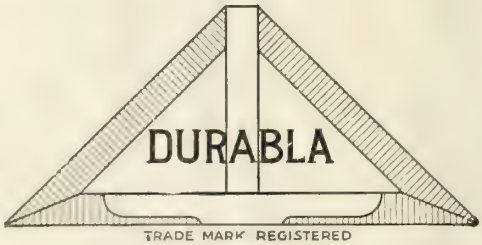
Established 1834

LEONARD

Perfect Service Gasket Material

Guaranteed to make a Tight Joint wherever a Permanent Gasket is required.

Place DURABLA in the next joints you make and be insured against a costly shutdown.



Strength; Goodness; Quality—these features distinguish durable Gaskets.

DURABLA Sheets can be rolled and unrolled; it never dries out or opens up.

DURABLA Compressed Asbestos Fibre Gasket Material is a guaranteed product that can be used as a standard for all Gasket work. DURABLA Gaskets make tight joints on Steam, Water, Oil, Ammonia and Acids at all temperatures and pressures.

DURABLA is not affected by vibration or condensation. It will not burn out, blow out or pulp at the points. Let us send you a trial sample. Made in stock sizes 36 in. wide x 144 in. long, and 48 in. wide x 144 in. long, in thicknesses of 1-64, 1-32, 1-16, 3-32, 1-8.

Orders Filled Promptly.

Made in Canada by Canadian Durabla, Limited

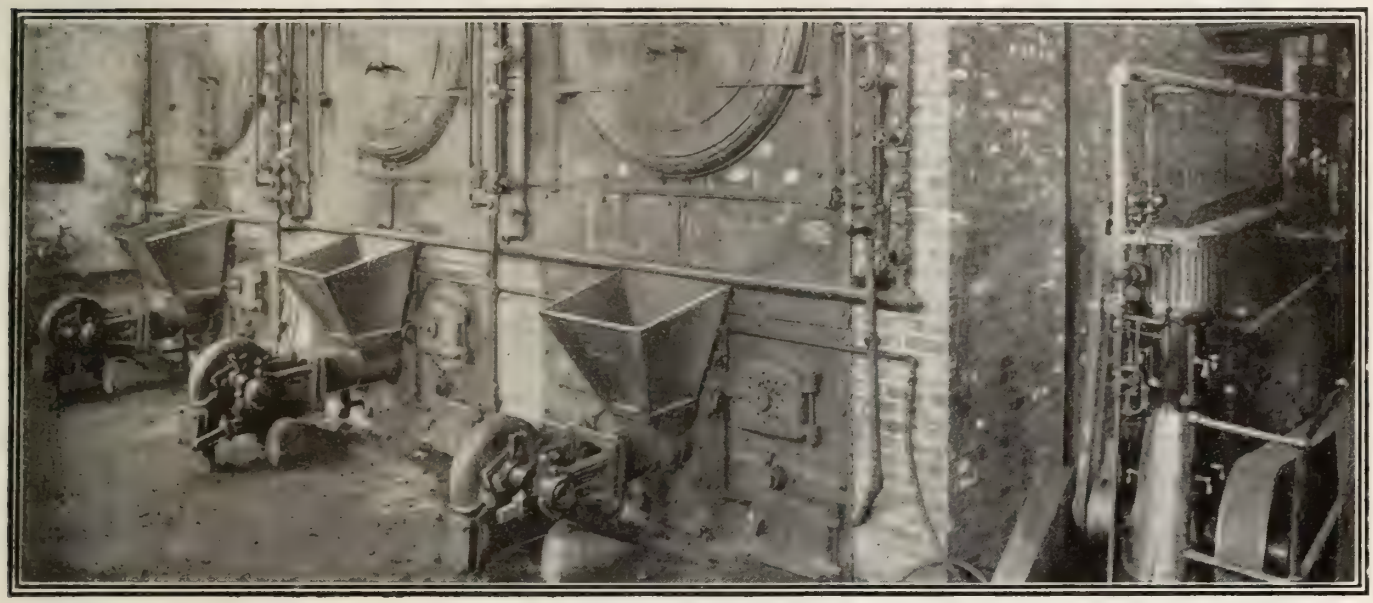
and sold on a service basis by

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

Sales Offices in all leading Canadian cities

DURABLA

Detroit Single Retort Underfeed Stokers can be Installed Profitably Under Tubular Boilers



Tubular Boilers fired by Detroit Single Retort Underfeed Stokers

Take the case of two power plants of approximately equal size and capacity. One of them had hand-fired furnaces, under tubular boilers, and the bad conditions of this type of firing had a psychological effect on those working in the boiler room. The place was in a generally ill-kept and unsatisfactory condition. The other plant, which also had tubular boilers, was equipped with mechanical stokers, and, perhaps, because the attainment of efficiency in combustion stimulated the firemen to better work all around, the boiler room was in first class condition. The first plant was using one and one half times as much coal as the second, and because of lack of efficiency in the boiler room, the cost of steam generation was actually twice the cost of production in the second plant.

When stokers were finally installed in the inefficient plant it was found that a cheaper grade of fuel than had previously been used could be burned, and that, due to the uniformity with which the stoker fed the fuel, the proper proportioning of air for combustion, the absence of large amounts of excess air, etc., it was possible to maintain a uniform boiler efficiency of approximately 70 per cent, whereas 55 to 60 per cent had been the rule before. The same amount of steam was generated with considerably less coal.

With the installation of the stokers, a transformation took place in the boiler room. The firemen began to display a hearty interest in their work. As a net result the cost of producing steam in the plant was reduced something like 50 per cent.

Ask for your copy of "Cutting the cost of Producing Steam." It describes Detroit Single Retort Underfeed Stokers and tells the story of the two plants mentioned in this advertisement in detail. Request Bulletin 238

DETROIT STOKER COMPANY

Underfeed Forced Draft and Overfeed Natural Draft Stokers

238 GENERAL MOTORS BUILDING DETROIT, MICH.

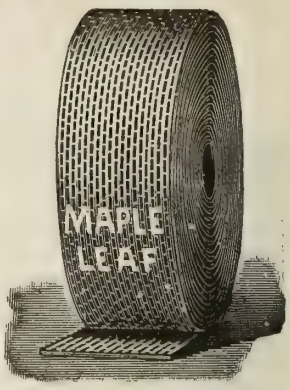
DETROIT UNDERFEED STOKERS

Dominion Belting Company, Limited

Hamilton, Canada

Sole Manufacturers of the celebrated "MAPLE LEAF" Brand Stitched Cotton Duck Belting and Belt Dressing.

The demand for our products has steadily increased because the standard of quality has been maintained.
We make only one grade, the best that can be produced.



"MAPLE LEAF" is the strongest, truest running, most economical and efficient belt on the market for transmission of power, conveying, etc.

Being thoroughly waterproof it is suitable for running in wet or dry places. **"MAPLE LEAF"** Belt Dressing is different to others offered in that it is equally good for all kinds of belting, leather, rubber, or Balata, as well as our own make.

Write us for prices, and if desired we will be pleased to furnish samples and further information.

A trial order will convince you of their utility

DOMINION BELTING CO., Ltd., Hamilton, Canada - Quebec Branch: 51 Duluth Bldg., Montrea

The Safe and Certain Boiler Cleanser

PUT a barrel of BOICO in your boiler room. It's the most efficient and economical **clean-boiler insurance** you can adopt. BOICO routs the most stubborn cases of boiler scale formations quickly and thoroughly.

Hundreds of Plants are Using BOICO Every Day With Unqualified Success

What BOICO will do in one plant it will do in another—**it will do in yours.**

BOICO loosens and brings away the hardest of old formations and keeps new scale from gathering. Yet it never does the slightest injury to boilers, valves or packings. Neither does it carry over in the steam, nor cause foaming or priming.

We are confident that BOICO will live up to all our claims and are prepared to let you test it FREE of cost. You have nothing to lose by trying it—let us hear from you.

Anti-Clinker Shell Bar Grates

There's no coal waste where these grates are used. Maximum air-space provides for perfect combustion. No clinker formation here, and you get more heat with less fuel.

One-Piece Jointless Furnace Lining

Why shift the blame on your engineer or fireman when it is your furnaces that are not up to the highest point of efficiency? USE PLIBRICO—it lasts longer than fire brick and is easier to instal.

Tip-It Patent Welding Process

With TIP-IT you get tools with shanks of carbon and tips of high-speed steel.

Shell-Bar Boico Supply, Limited 1-15 Saunders Ave., Toronto

Sales Agents: Mill Supply Department, Beveridge Supply Co., Ltd., Montreal; Adolphe Huot Reg'd., Quebec; Adam Davis, Cobalt, Ont.

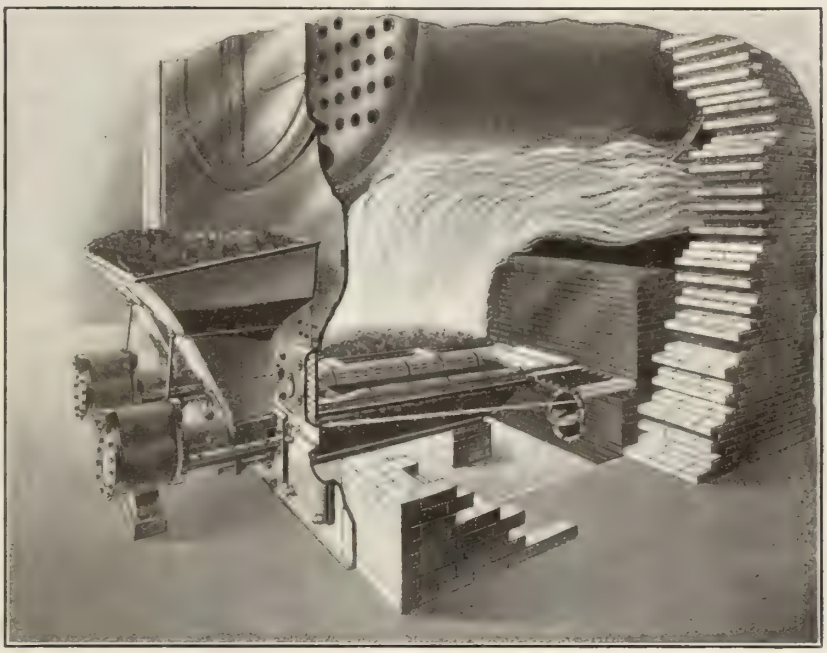
MACLEAN STOKERS

No Special Knowledge

is required to operate the **MacLean Underfeed Stoker.** It is very simple and **automatically** regulates the feed of fuel and air so that **complete combustion** is ensured. Apart from the great saving in labor, increased steaming capacity and improved conditions, it will fire your boilers on soft coal **without smoke.**

Let us estimate just what the MacLean Underfeed Stoker could save in your plant — no obligation.

The Coal it saves soon pays its cost.



The MacLean Underfeed Stoker Co.
LIMITED
95-97 King Street East, Toronto, Canada.

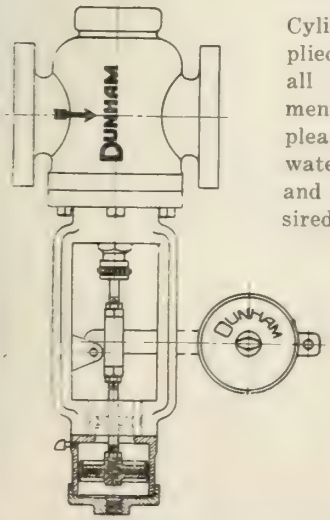
The DUNHAM HEATING SERVICE

REG. TRADE-MARK

(Made in Canada.)

REDUCING PRESSURE VALVES

High Pressure Cylinder Type No. 305
Cross Section of Cylinder



Cylinders can be supplied in sizes to meet all pressure requirements. When ordering please specify steam, water or air service, and the pressures desired.

For High Pressure Reduction

70 to 300 Pounds or More

Where steam, water or air is to be reduced to pressures exceeding seventy pounds we recommend the installation of the Dunham High Pressure Cylinder Type Valve. Unlike the more commonly used Dunham Reducing Pressure Valves which are diaphragm equipped, this valve is constructed with a cylinder and piston specially designed for high pressure delivery service. It obtains constant pressure reduction and affords an adjustable variation of sixty pounds by means of weights.

Like all the products of the Dunham Line, this Reducing Pressure Valve embodies only the finest materials and expert workmanship, insuring dependable and lasting performance.

Write for additional data.

C. A. DUNHAM CO., LIMITED

TORONTO, ONT.

Manufacturers of a popular line of heating specialties

Halifax, Vancouver, Winnipeg, Ottawa, Montreal, Calgary, London, Eng., 18 St. Thomas St., S.E.1.

For Maximum Power Delivery Install "P M S" Belting

Two principal factors enter into maximum power delivery: efficient transmission and continuity.

"P M S" excels in both of these. By its greater adhesion to the pulley it gives a high percentage of efficiency. By its great strength it reduces breakdowns and adjustments to the minimum.

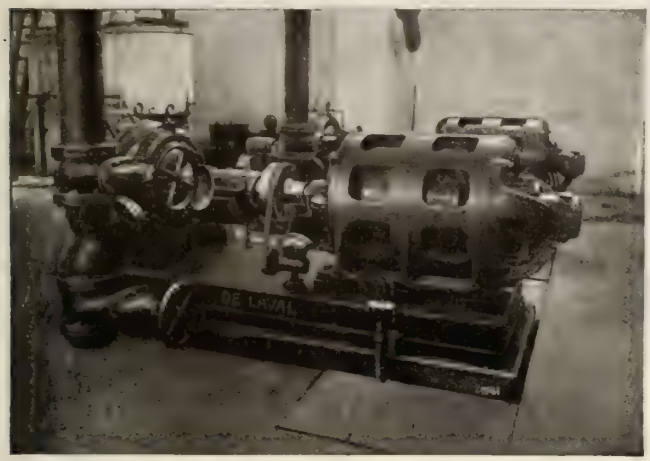
On this basis, we claim it is the best for your plant —will you test our claims?

Manufactured Exclusively by

Gutta Percha & Rubber, Limited

Head Offices and Factories, Toronto, Canada

Branches in All Leading Canadian Cities



Pressure Easily Regulated

THE two De Laval two-stage 8-inch centrifugal pumps designed for 1,440 g.p.m. each against a maximum head of 325 feet, shown in the photograph, are installed in the water works pumping plant of Orillia, Ont. They are driven by variable speed motors, by means of which the pressure upon the system can easily be varied. Upon each base plate is mounted a tachometer driven by belt from the motor coupling, also suction and pressure gages, so that the operator can at all times know the speed and the pressure developed, from which it is possible to determine approximately the amount of water being delivered. The characteristic curves obtained when the pump was subjected to the regulation shop test show the delivery at other speeds and pressures.

The same station also contains a De Laval two-stage pump driven by gasoline engine, to insure continuity of service under all circumstances.

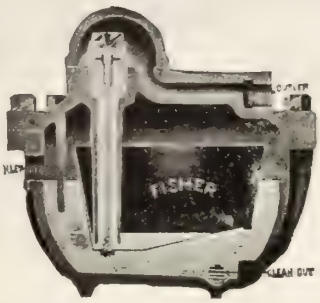
De Laval centrifugal pumps are ideal for motor drive because of their low starting torque and high efficiency. The motor can be selected to develop its highest efficiency at the normal rated delivery, which is conducive to high average efficiency and to high power factor in induction motors.

Describe your pumping requirements, and our engineers will be glad to make suggestions. Ask for special publication B-100.

DE LAVAL
STEAM TURBINE CO.

Turbine Equipment Co, Ltd., 73 King St. West, Toronto.
The E. Laurie Company, 243 Bleury St., Montreal, Quebec.
Taylor Engineering Co., Ltd., Vancouver.

245



Steam is Money— Don't Waste It!

Condensation—the parasite—saps the life and energy of your steam. To let it remain in your pipe lines is equivalent to actual squandering of money.

Condensation is quickly and completely removed from your pipe lines by the

FISHER STEAM TRAP
(Type 33)

It is a positive-acting steam trap that gives your steam a clear track. Your steam courses through the pipes dry and hot to the very end of the system.

The Fisher Trap helps maintain even heat —it pays for itself in the coal it saves.

Its sturdy construction insures a long life of satisfactory service. It never leaks—Monel metal valve and seat practically eliminate wire drawing.

Sufficient water is left in the bottom of the bucket to insure a perfect water seal at all times.

The Fisher Trap is proving itself a true friend to engineers throughout the world.

Our book, "THE FISHER TRAP," was written for you. Write for it to-day.

THE FISHER GOVERNOR CO.,

940 Fisher Ave., Marshalltown, Iowa, U.S.A.

Agencies in all principal cities

FISHER
TRADE MARK
REGISTERED

TO ALL—

We wish you a very Merry Xmas and a Happy and Prosperous New Year

The Linde Canadian Refrigeration Co., Limited

37 St. Peter Street, MONTREAL, Que.

TORONTO WINNIPEG VANCOUVER

Jamison **HEAVY DUTY**
Cold Storage Doors
Scientifically Built

The scientific construction of the Automatic Self-tightening Fastener is a notable feature of all our doors. The harder the door is slammed the tighter the fastener holds the door shut—no slackening as it fastens.

Send for Catalog No. 10—it explains in detail the numerous features which have kept **Jamison** doors in advance of all competition.

JAMISON COLD STORAGE DOOR CO.
(Formerly Jones Cold Store Co.)

HAGERSTOWN MARYLAND, U.S.A.

YORK Ice Making & Refrigerating **MACHINERY**

For Every Practical Purpose
Consultation on any Refrigerating Problem invited.

CANADIAN ICE MACHINE CO., LIMITED

Villiers and Munition Sts., Toronto — 1415 Whyte Ave., Winnipeg
324 Craig St. West, Montreal — 1158 Homer St., Vancouver

OIL BURNING SYSTEMS

INSTALLED IN LAUNDRIES, FACTORIES, APARTMENTS, ETC.
COMPLETE POWER PLANT EQUIPMENT AND SUPPLIES.

LAURIE ENGINE CO.

(The Service Engineering Company of Canada).
601 NEW BIRKS BLDG., MONTREAL, QUE.

THOMSON-GORDON LIMITED

ENGINE
PACKINGS

HAMILTON ONTARIO
2

Investigate These—

They Mean More Heat with Less Fuel

If you are willing to be shown that **Cole Traps** will reduce your power costs, write us about it and we will give you concrete cases where **Cole Traps** not only reduced costs but did so where other systems failed even to give service.

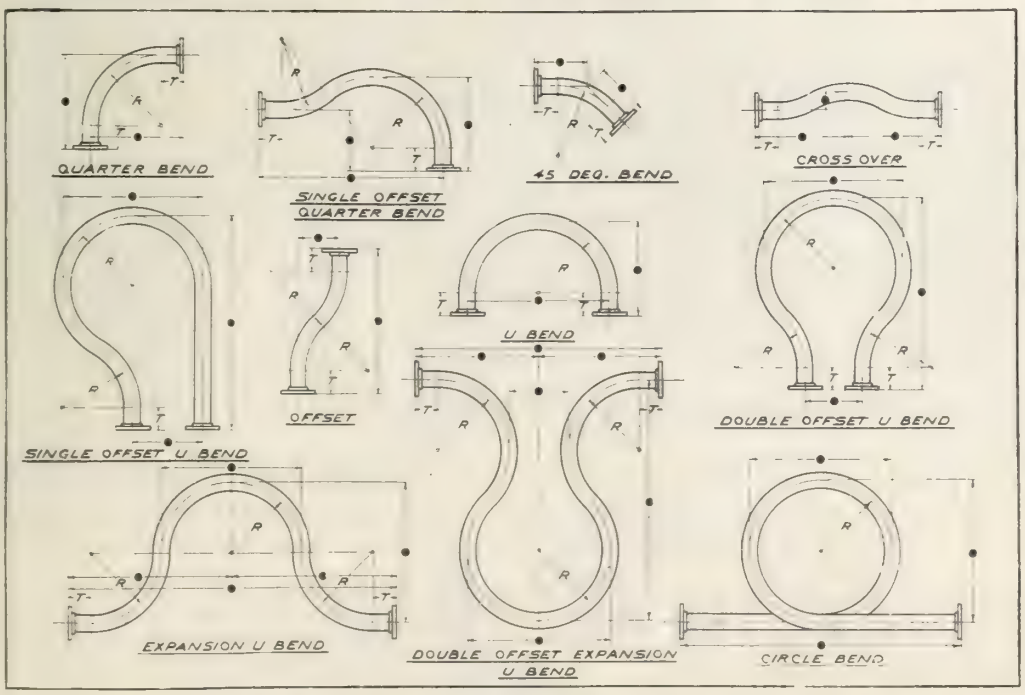
Evertite Boiler Covering is another Cole product and will save from 3% to 10% on your coal bills. It saves coal and increases efficiency by keeping your boiler settings absolutely air-tight.

Let us tell you more about these.

GRANT E. COLE CO.

21 River Street ∴ Toronto

WROUGHT PIPE BENDS



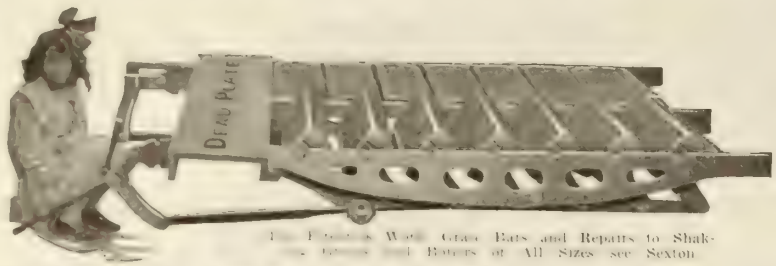
ALL KINDS AND SIZES UP TO 10" DIAMETER

MADE IN CANADA BY

PAGE-HERSEY TUBES, LIMITED

100 Church Street, TORONTO, ONT.

NONPAREIL Shaking and Dumping GRATES



"Safety - First" Sexton—

Takes this opportunity to wish his many business friends

A Merry Christmas
and a
Prosperous New Year

THE W. R. SEXTON BOILER SETTING COMPANY

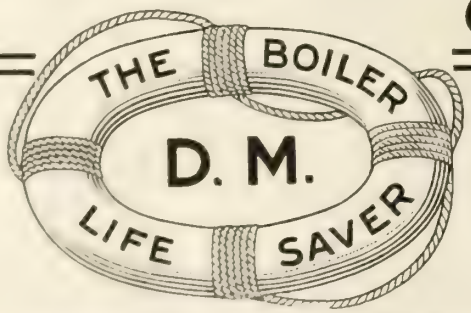
114 Grenadier Road, Toronto
Phone: Jct. 2765-W.

May happiness and peace and wealth,
Smiling faces, endless joy,
Prosperity, with perfect health,
And kindliness without alloy;
True friends, a gladsome Christmas cheer
For you and yours, last through the year.

Merry Christmas 1922

AMERICAN STEAM PUMP CO.
BATTLE CREEK, MICHIGAN

Get the Most *Out of Your Fuel*



Keeps your boiler clean and thus eliminates repair bills, besides reducing maintenance cost.

Will not injure boilers or fittings.

No acid — No chemicals — Just "D. M."

"D.M." Boiler Compound is a Vegetable composition, absolutely harmless, and will keep your boilers clean right down to the bare metal. Prevents all scale formation, corrosion and pitting. "D.M." Boiler Compound is used by many of the largest users of steam throughout the world including the British Government.

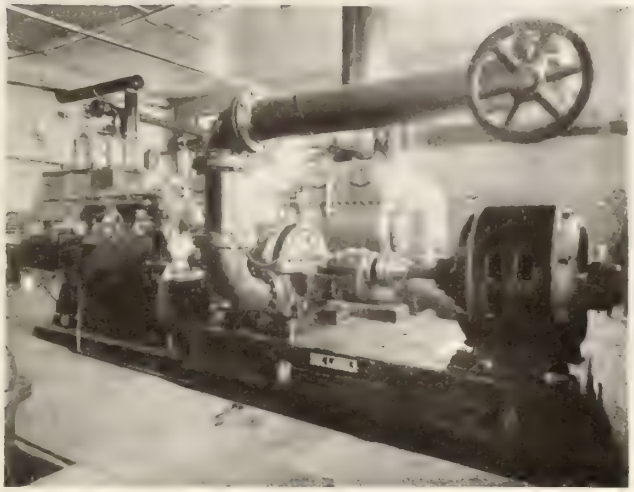
Manufactured by: HOUSEMAN & THOMPSON, Ltd., Newcastle-on-Tyne, England.

Sole Distributor for Canada:

J. A. CARRUTHERS - 23 Scott Street, Toronto

Power Insurance

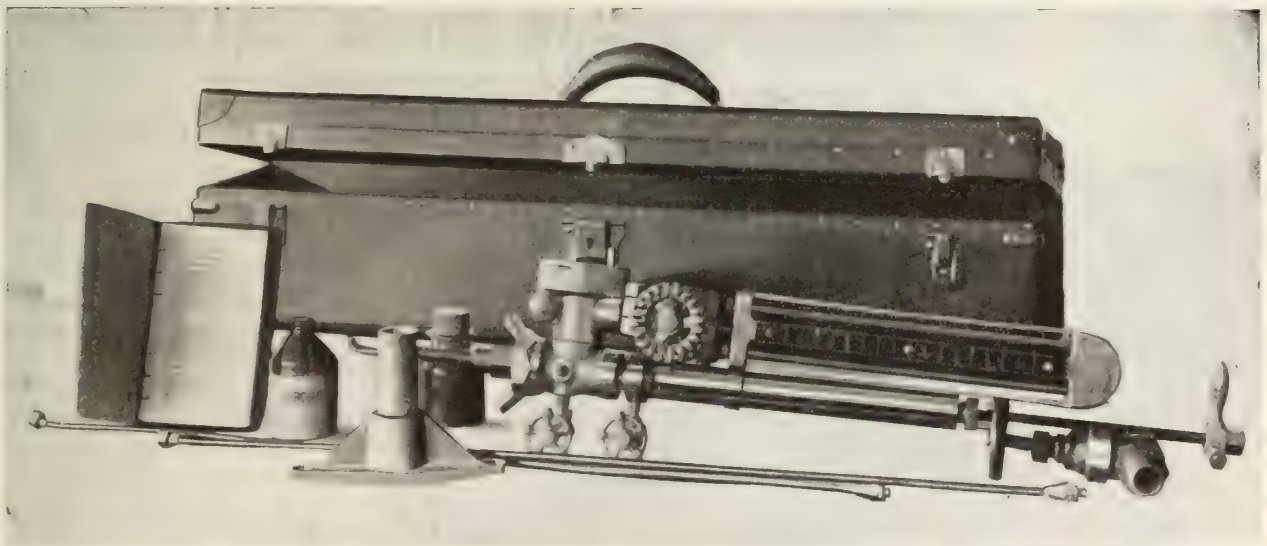
Use STERLINGS during emergency (storms or mechanical breakdowns) for peak load, and to reduce power costs for fire protection. State boards of health frequently insist on duplicate power in sewage systems. Fire Underwriters demand a secondary power and often lower the insurance rate, or raise it if a standby unit is not used. Costs $20 to $25 per H.P.



6 Cylinder 145 H.P. STERLING direct connected 2 stage De Laval centrifugal, 1,500 R.P.M., 1½ million gal. per day, 280 ft. head. Reserve pump installed at Bath Water District, Bath, Me., by Power Equipment Co., Boston, Mass.

STERLING ENGINE CO. Dept. C-4 Buffalo, N.Y.

40 to 300 H.P. at 1,200-1,500 R.P.M.



Cory-Royer Flow Indicator

Portable and Stationary Flow Indicators for steam, air and liquids. Simple—Reliable—Safe. (Write for information.)

CHAS. CORY & SON INC.

183-7 VARICK STREET - - NEW YORK CITY

VANCOUVER

P. A. Goepel,
525 Pender St. W.

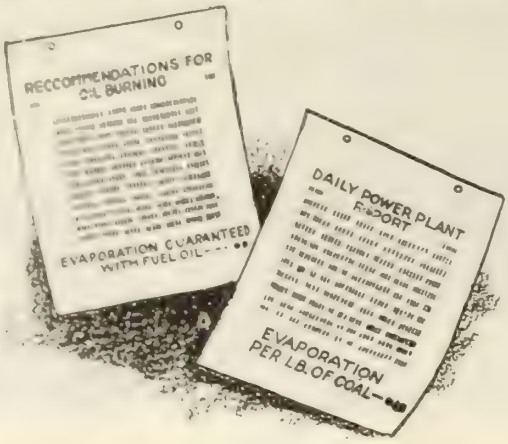
Est. CORY 1845

TORONTO

The Canada Stoker Co., Ltd.,
31 Bank of Hamilton Chambers,

Coal or Oil? The VENTURI Meter

"VENTURI" Registered


RECCOMMENDATIONS FOR OIL BURNING
EVAPORATION GUARANTEED WITH FUEL OIL
DAILY POWER PLANT REPORT
EVAPORATION PER LB. OF COAL

WILL GIVE YOU FACTS on which you can make a correct decision. Many factors have to be taken into consideration and each power plant is a distinct problem. The essential fact of pounds of water evaporated into steam per pound of fuel burned must be accurately known.

The Venturi Meter has a record of over 20 years' service in the boiler plant and is universally accepted as the **standard meter** for measuring boiler feed water. It registers, indicates and records the flow. The instrument may be located at the point where its readings can be most easily observed. The measuring capacity is changed at slight expense. There are many other features of the Venturi Meter which commend it for this difficult service.

Engineering Bulletins on Request

Builders Iron Foundry, Providence, R.I.

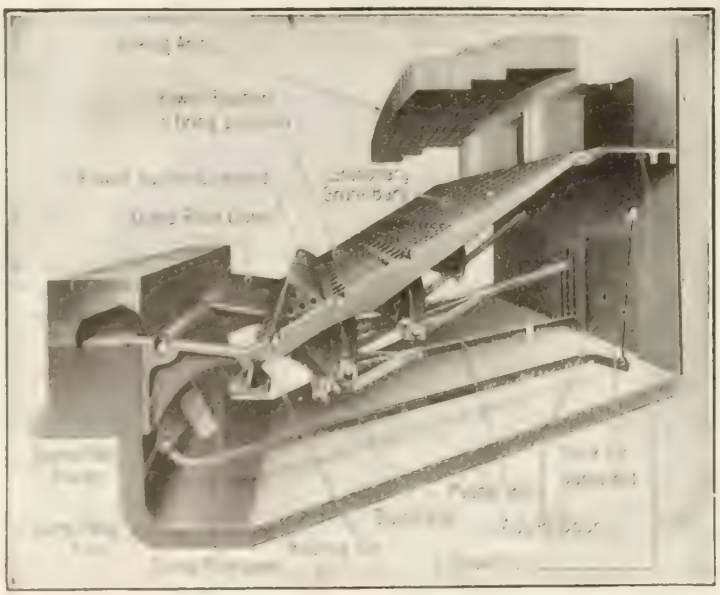
Canadian Representatives:

General Supply Co., of Canada, Ltd.
Ottawa Montreal Winnipeg Vancouver

Allen General Supplies Limited
Toronto, Ontario

The National Hand Fired Stoker

Effects Big Savings -



The heavy labor of firing is eliminated and low grade labor with very little training can get excellent firing results. Any grade of fuel can be used and smoke is practically eliminated with any grade of fuel. There is no fuel in the combustion chambers and no ashes in the flues, while there is decided increase in Boiler capacity. The banks of Pushers operated by rods by hand from the front of the furnace, keep the fuel moving downwards until the dump grates are reached —ensuring just about PERFECT COMBUSTION.

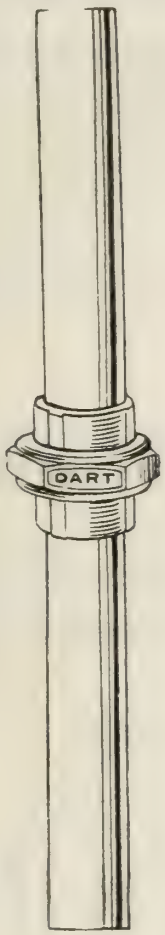
Installed under new or present Boilers. Booklet.

Engineering and Machine Works of Canada, Limited

ST. CATHARINES, ONT.

EASTERN SALES OFFICES:
Hall Machinery Co., Sherbrooke, Que., and Birks Bldg., Montreal.

Dart Unions Never Leak— They Are Made That Way



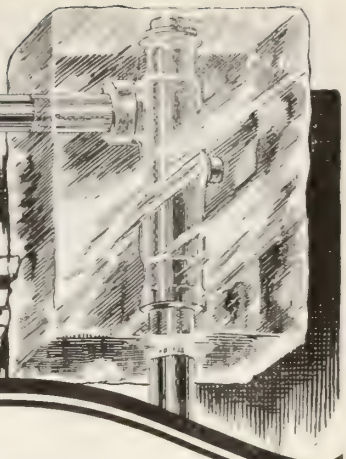
BRONZE TO BRONZE AT THE JOINTS THAT'S THE REASON

This Name
DART

Appears on Every Union or Fitting We Make. It is Your Guarantee.

DART UNION CO., LIMITED
TORONTO

SARCO Trap Can't FREEZE



Even in zero weather the Steam Trap Sarco—when installed outside of a building—will not freeze or allow freezing of the steam line. It CAN'T freeze because it is opened by condensation and closed by steam.

When steam is shut off, the Sarco opens automatically and stays open until steam is again applied—then the steam forces all the air out and closes the trap until condensation opens it. No water stays in the trap or in the line.

This is a big advantage, for it enables you to place steam traps **at all points that ought to be trapped.**

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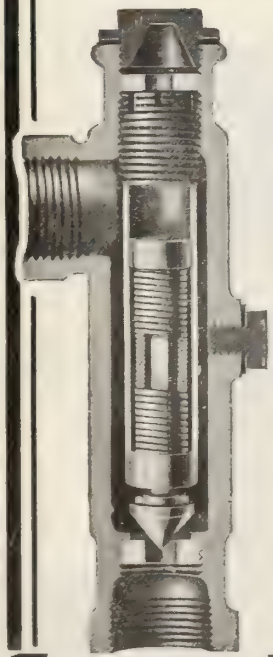

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Exploding an Old-Time Boiler Fallacy

An Analysis of the Theory That Cold Water Sprayed Upon a Red-Hot Boiler Plate Instantly Generates an Uncontrollable Volume of Steam

By W. B. ROBERTS

IT IS the object of this article to thoroughly investigate and analyse a theory that appears to be gaining a strong foothold in this country, relative to the action of cold water upon a red-hot boiler plate. Those who care to investigate, will find that a very large percentage of engineers believe that cold water brought in contact with a red-hot boiler plate instantly creates a highly elastic vapour, which is so powerful and uncontrollable that no boiler would be strong enough to resist or withstand its effect. In some remote cases it has been advocated that explosions have occurred due to the ignition of hydrogen gas, produced by the decomposition of water coming in contact with the red-hot plates. We have only to look at a report issued in one of the daily papers on a boiler explosion that occurred this year in Canada, when we were informed—**"It is the general opinion of marine men who have inspected the boiler and wreckage, that cold water in the boiler was the cause of the disaster, but there is no official statement to confirm this report. The drawing of cold water into the boiler at a time when the crown sheet of the boiler was red-hot would have caused the blast, etc."**

We cannot close our eyes to the mischievous tendency that such a belief creates. Firstly, it diverts the attention from the true cause of the explosion, and secondly, it has a bad influence upon engineers who have charge of boilers. An engineer who accepts such a theory would naturally expect immediate disaster if he injected cold feed-water upon a red hot plate in his boiler. When we realize that self-preservation is one of the strongest instincts we possess, it is very natural that a man will not knowingly stand beside a boiler if he thinks it will burst.

It will therefore be readily seen that the acceptance of such a theory will not be conducive to the best results from any engineer, whereas, with a full knowledge of the whole truth, he could meet the situation of a red hot plate with the greatest equanimity.

With reference to the theory of "The generation of gas," we can dismiss this without further comment, and we think those who read this article will be well assured and satisfied that this does not actually occur. If, on the other hand those who give credence to "The rapid and instantaneous generation of steam" theory, would only consider the specific heat of iron compared with that of water, they would see that this theory is also doomed to disaster. The specific heat of iron (.113) compared with that of water (1.00) is so low that no large volume of steam could actually be generated under the circumstances. However, it is not our intention to prove the fallacy of such a theory by formula, but to prove from experiments actually conducted upon a boiler, that under such circumstances nothing unusual happens and there is nothing really mysterious about any boiler explosion.

We do not suggest that a plate in a boiler is not very materially weakened due to becoming over-heated. We know that bulges and bags on the plates of the furnace of a H.R.T. boiler are invariably caused by this condition, and it is possible and even probable that explosions have actually occurred due to this same cause. A boiler explosion is always caused by excessive pressure. It may be suggested that the plate of a boiler might be defective or wasted, but if the working pressure was determined to provide for such weakness or defect, the boiler would not explode.

Some years ago there was a regular epidemic of boiler explosions in Eng-

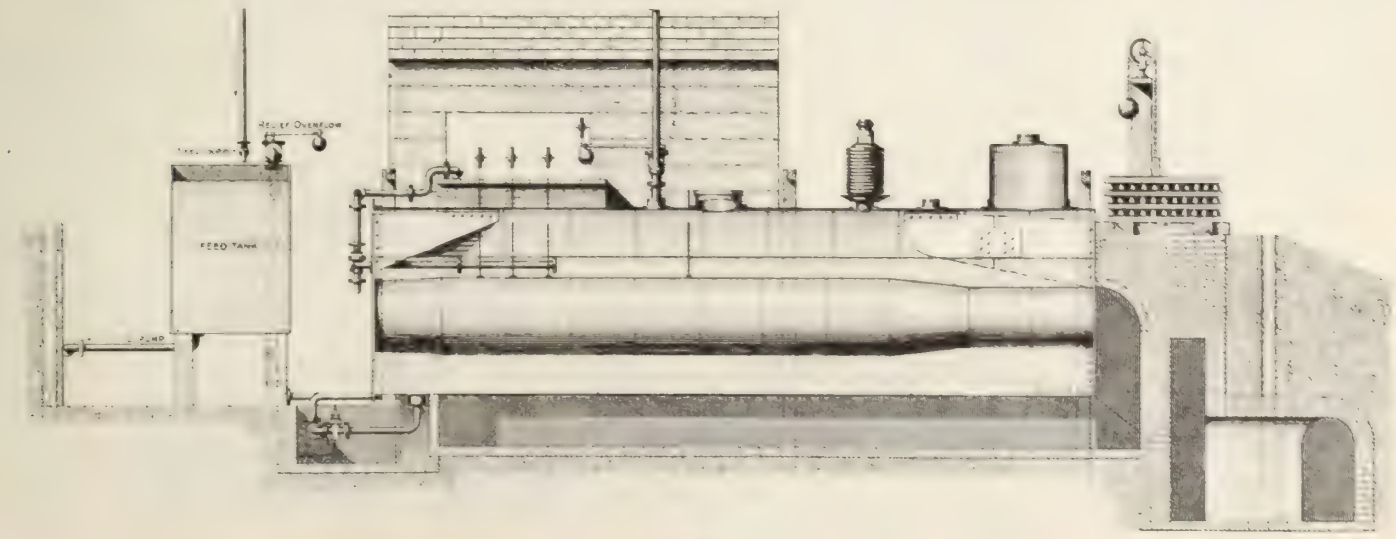


Fig. 1.

land. In many cases the cause for these disastrous happenings was said to be due to "A sudden and violent generation of steam" or "The explosion of a gas internally." However, whatever the cause the results were equally disastrous and it was thought that the time was opportune to thoroughly investigate the circumstances of such happenings and disprove any theory that savoured mystery.

At this time the Manchester Steam Users' Assn. undertook to conduct an experiment with a full size boiler, and after much reluctance on the part of the various authorities, to give their consent, it was eventually granted. Needless to say, such an experiment was greatly criticised and there were no few advisers who enlarged upon the dangers involved and predicted disaster.

A site was eventually secured on a piece of waste ground outside of Preston near to the boiler shop of Joseph Clayton. It was also necessary to take every precaution to protect observers, and persons in the vicinity outside the works. To effect this the boiler was set in a pit with large barricades built on either side and reinforced with earth. The observation pit was constructed some distance away and barricaded in a similar way to protect those conducting the experiment.

Selection of Boiler

It was decided that the boiler most suitable and adaptable for this experiment would be an ordinary Lancashire boiler and one was secured 7 ft. 0 in. diameter, 27 ft. 9 in. long, shell plates 7 16 in. thick, and plates 9/16 in. thick, furnace tubes 3 ft. 0 in. diam. and plates 7 16 in. thick. The boiler was set upon a proper standard brick setting and equipped with all the fittings necessary for a boiler of this type. Many additional fittings were essential to conduct the experiment successfully. An internal dispersion pipe was arranged directly over the furnace in the location of the plate that was to be over-heated and heavily perforated such that a uniform spray of cold water could be directed upon the hot plate at the required time.

These pipes were 7 ft. 0 in. long and extended from the front plates to the level of the bridge wall. The ends of the pipes were perforated on the bottom with about 35 ¼ in. holes, set 1¼ in. apart and in a position to direct the cold spray of water immediately on the red hot plate of the furnace. They were capable of discharging 5 to 6 cubic ft. of water per minute against a pressure of 25 lbs., which would be the pressure at which the boiler would operate. Fig. 2.

It was also necessary for the observers conducting the experiment to have some instrument or apparatus fitted in order that they could closely observe any movement, in the form of hogging or sagging, of the furnaces, and furthermore keep a close record of any distortion of the furnace in the form of bulging that would occur. To effect this, screwed plugs were fitted into the crown of the furnace equidistant over the length of the actual fire-grate.

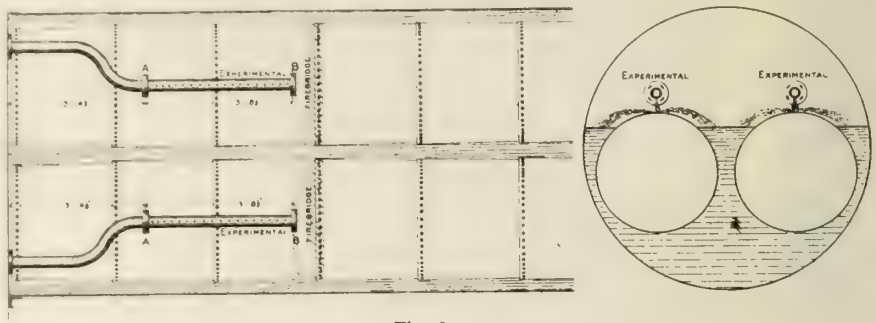


Fig. 2.

The screwed end was attached to the furnace with a disc of tin alloy to form a fusible plug. This alloy was specially prepared by a firm of analytical chemists so that the alloy would not melt at a lower temperature than the temperature of a red hot boiler plate. By having this arrangement we know immediately upon the release of one of the plugs that the plate is red hot. We might further add that tests were conducted on this alloy, on a plate similar to the arrangement in which they would be fitted in the furnace, and the alloy was not dislodged or melted until the plate was a blood red heat.

These plugs were attached to weighted rods and passed through glands at the top of the boiler shell. From these rods wires were led over pulleys to a recording board in the observation pit. See Fig. 1. It will be seen from the sketch that any up and down movement in the furnace crown will be immediately recorded on the observation board when complete records would be kept. The observation pit was also fitted with a blow-out tap in order that the water in the boiler could be lowered at the desired moment; a feed valve to regulate the cold spray on the red hot plates at the required time; extra glass water gauges to indicate the water level; a pressure gauge and a clock. A plan end and side elevation of the general arrangement is given in Figs. 1, 3, and 4.

With a view of saving time the water that was pumped into the boiler was first passed through an economizer in some of the tests, and the temperature of the water stood at an initial temp. of 150° F. We will, however, take the test where the boiler was filled up with cold water, as this will be conducting the test under more normal conditions. Although the boiler was built for 80 lbs., the safety valves during this test were only set for 25 lbs.

TEST

In preparation for this test the fires in the boiler were lighted and kept burning for two days so that the draught would be good and the brickwork warm. The experiment was commenced at 6 p. m. when there was 9½ in. of water above the level of the furnace crown, and the steam pressure gauge standing at zero. The fires were then shaken up.

At 6.30 there was 25 lbs. of steam showing and the safety valves began to blow. At the same time the blow-off tap was opened full bore, there being 9½ in. of water covering the crown of the furnaces.

At 6.38 p.m. the water level in the boiler had receded to the level of the furnace crown. The fires at this time being good and fierce, they were left in

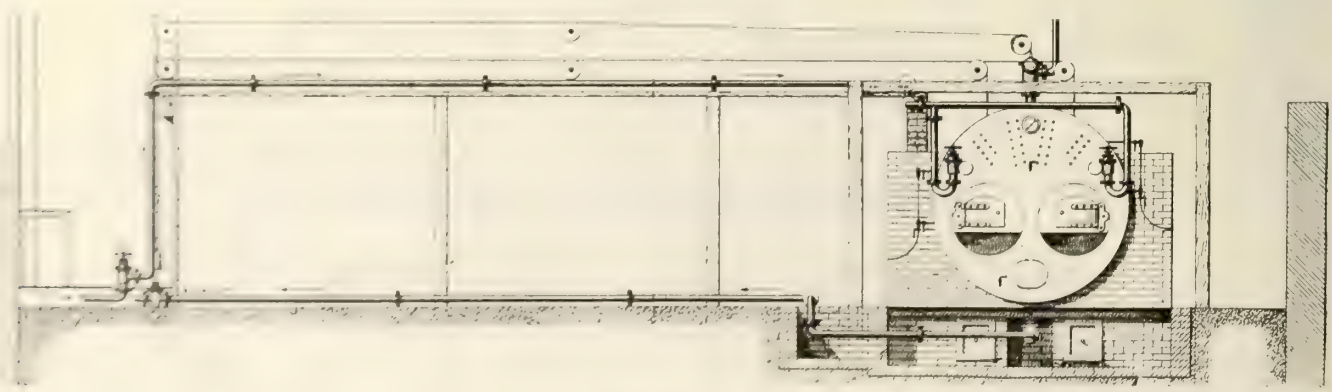


Fig. 3.

a condition wherein they would remain in that state as long as possible. The fires were 9 in. thick on the fire-bars burning briskly and the dampers were opened full, showing a draught in chimney of ½ inch on the gauge. The steam at this time was a few pounds in excess over 25 lbs. and the safety valves were blowing off violently. At this stage the observers withdrew from the boiler front to take records from their instruments in the observation pit.

At 6.56 p.m. and 18 minutes from the moment the furnace crown became exposed, one counterbalance weight fell on the observation board attached to the left furnace.

At 6.59 p.m., 21 minutes after the time the furnace crown became exposed, the falling of another counterbalance weight indicated that a second plug was dislodged from the alloy in the [illegible] hand furnace.

At 7-1½ p.m., 23½ minutes from the moment the furnace crown was first exposed, the third counter-balance weight dropped in the observation pit; this time from the right-hand furnace. At this moment the level of the water was 3⅝ in. below the crown of the furnace, thus laying bare and exposing a strip of plating 21 in. wide, at a temperature of about 700° F. with a pressure of 28½ lbs. of the boiler and the safety valve blowing freely. The feed water was immediately turned on, which would be conveyed through the dispersion pipe and sprayed directly on the red-hot plates. The temperature of the feed was about 60° F. and the rate of injection a little more than 4½ cubic feet of water per minute.

Showering the feed water at a temperature of 60° F. on a red-hot furnace crown was not attended with any increase of pressure. On the contrary the pressure at once began to fall and in 2½ minutes had fallen from 28½ lbs. to 26 lbs. pressure.

The rate at which the temperature rose and fell will be seen by reference to diagram in Fig. 5.

Upon looking into the furnaces the ring seams of the furnace tubes were leaking freely. The crown of both furnace tubes was discoloured on the fire side, for about 12 in. wide to a length of about 8 or 9 feet.

On making an examination of the boiler the following morning, it was found that the overlaps of the first seven ring seams in each furnace were sprung at the crown, but the shape of the furnace tubes was practically unaltered, except the right-hand tube was slightly bulged in three places. Two of these bulges were situated on the crown of the second belt, one measuring 7 in. x 12 in. x ¼ in. and the other 9 in. x 12 in. x 3/16 in.

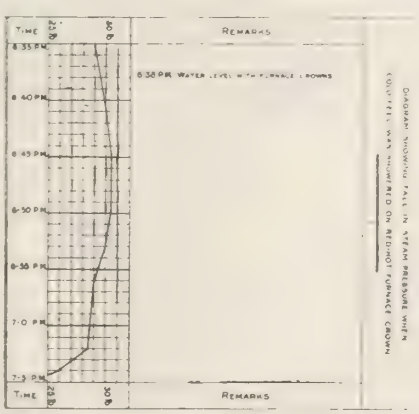


Fig. 5.

A third bulge was situated at the crown of the third ring seam measuring 11 in. x 10 in. x 5/32 in. deep. It was also seen that all the fusible discs on both furnace crowns had been melted. It would be just as well to here explain that the fusible plugs mentioned in this test are not the fusible discs usually used in ordinary boilers as there was no orifice running through them. They were simply fitted on the top of the furnace to indicate the temperature to which the furnace had been heated by the melting of the alloy.

In addition to the fusible discs and plugs a strip of lead 4 ft. x 1½ in. x 1/16 in. was laid across the middle of the first eight belts of plating of the furnaces as an indication how far along the furnaces the overheating would extend. It was found upon examination that five of the strips on the left-hand furnace and six on the right-hand furnace had been melted. There can therefore be no possible doubt that the furnace crowns had been red hot.

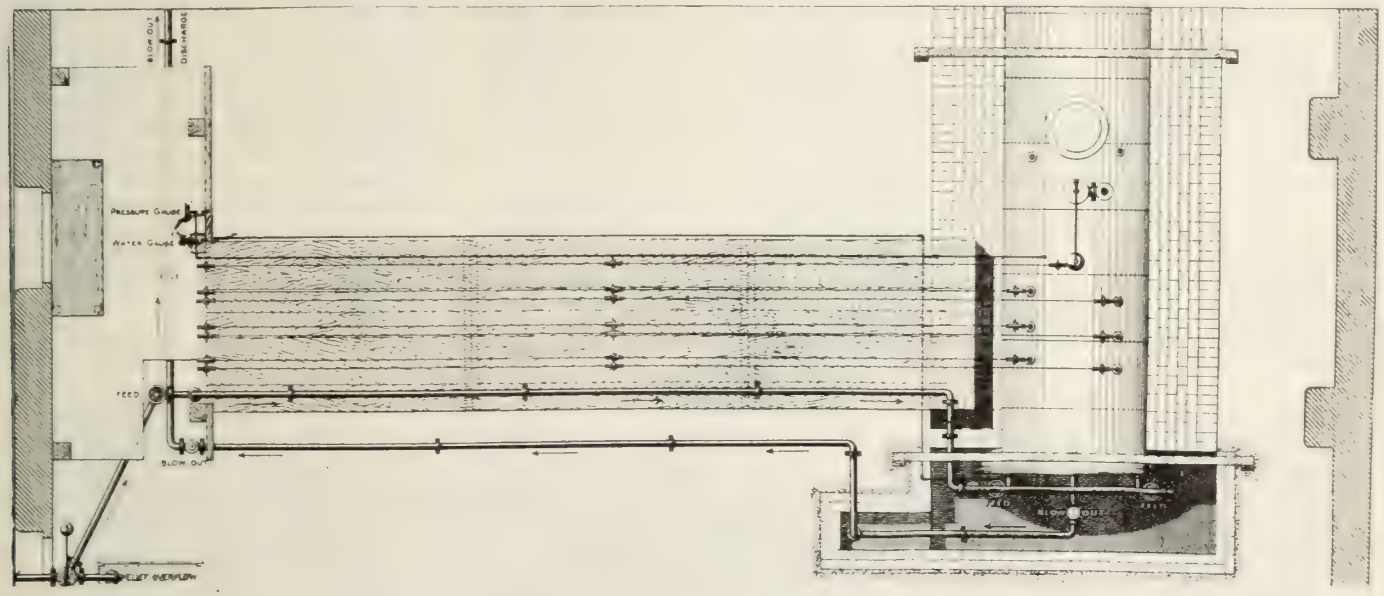


Fig. 4.

The results of these tests, which are plainly evident, clearly show that spraying red hot plates in furnaces did not lead to the ripping of the plates, circumferentially or longitudinally, due to sudden contraction or uneven expansion, and furthermore, did NOT CAUSE ANY INCREASE OF PRESSURE due to a violent and sudden generation of steam, but rather to the contrary SHOWED A SLIGHT REDUCTION in pressure.

The type of boiler that we have dealt with in these tests, is not one usually found in this country, although there are a few. However it was only used as a convenience to disprove the fallacy of a certain theory, and the results obtained are applicable to all boilers.

An attendant should never neglect his water supply, and if there is any doubt, he should make doubly sure of his water level before brightening up his fires. If these simple precautions were taken by everyone who look after boilers, even night-watchmen, there would be few cases of low water in a boiler, but if due to some unavoidable cause, the level of the water in the boiler is found to be low, do not hesitate in opening up your feed supply full and as a precautionary measure, draw your fires or at least dampen them down.

Pumping Engine Arrangements for Waterworks

The Development of Modern Pumping Machinery Showing the Most Economical Arrangement—Giving An Analysis of British Methods Compared With Those Used in America

MAJOR JOHNSTONE TAYLOR

Of all mechanical machines of what may be termed the heavy class, the modern waterworks pumping engine is perhaps the finest example. The slow engine, with its almost silent operation, must appeal to the unmechanical mind far above the ordinary run of machinery, whilst for reliability and efficiency there are few if any machines to compare with it. Despite the advance in the design and construction of the centrifugal pump and the undoubted convenience of the electric motor for driving it, the steam driven reciprocating engine still continues to hold the field where pumps are required for large water supplies. For smaller plants no doubt the centrifugal pump has several advantages, whilst the power-pump driven by gas or oil engine, has much to recommend it.

With this class of plant however, this article is not directly concerned, since it aims rather at discussing from a general standpoint the high duty steam driven waterworks engine. The continued adherence to the reciprocating steam engine, which for other purposes has been so much superceded by other forms of prime mover, is not far to seek.

The duty of waterworks pumping engines demands two essential qualifications, i.e., reliability and efficiency. No form of engine has yet been built which is more reliable than the slow speed steam engine and few can compare with it. Its efficiency when constructed, especially for economical operation, is exceptionally high.

These engines, certainly as far as British practice is concerned, are highly finished externally, having the cylinder lagging bonded with polished Russian iron. The external rods are all highly polished and the gauges and indicators grouped on a board at the front of the engine. The whole machine, when well cared for, has a most imposing appearance, and although appearance has nothing whatever to do with efficiency, a good one displays pride of work on the part of the builders, and is usually no mean indication of a good machine.

Types

There are two main types of water-

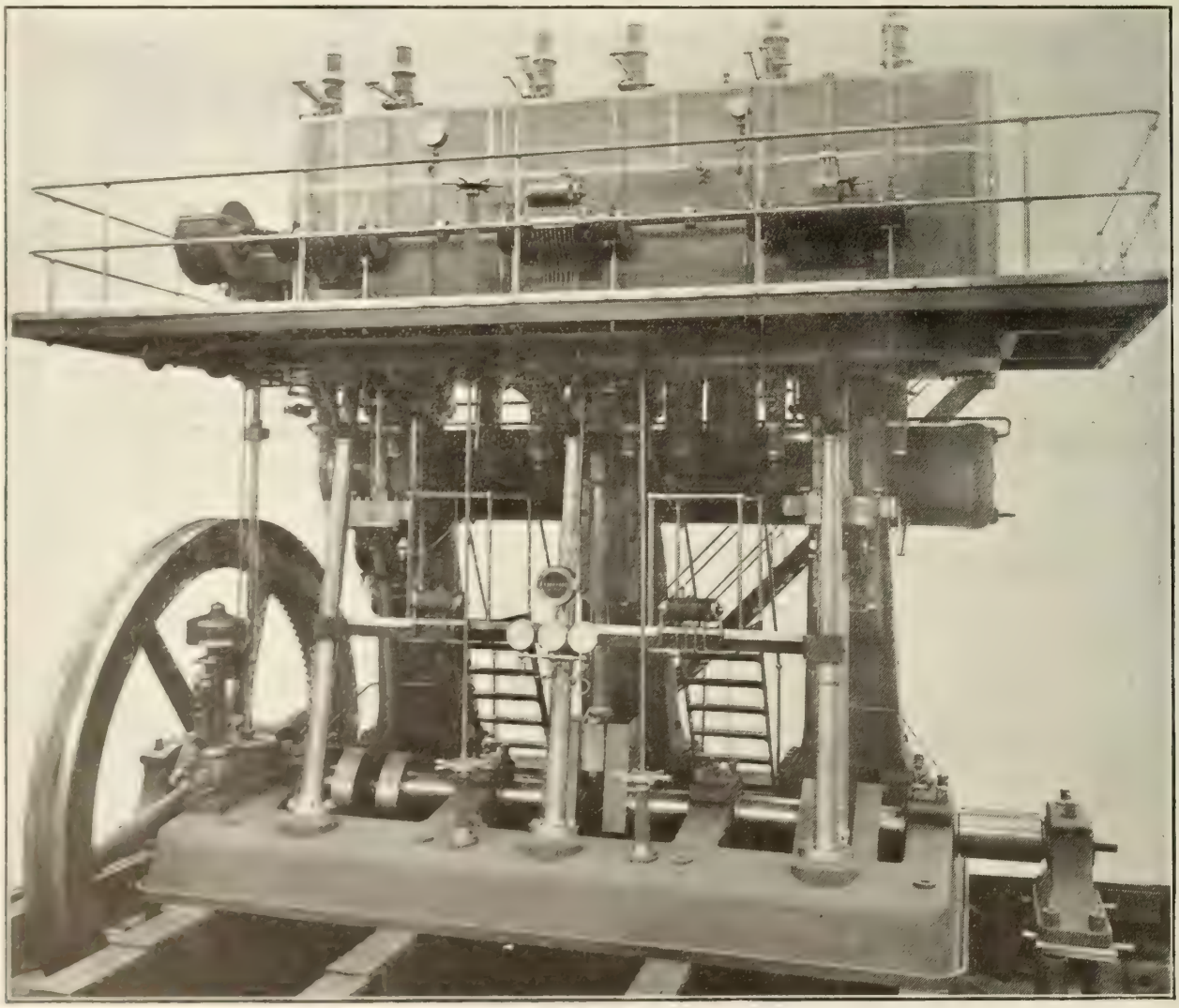
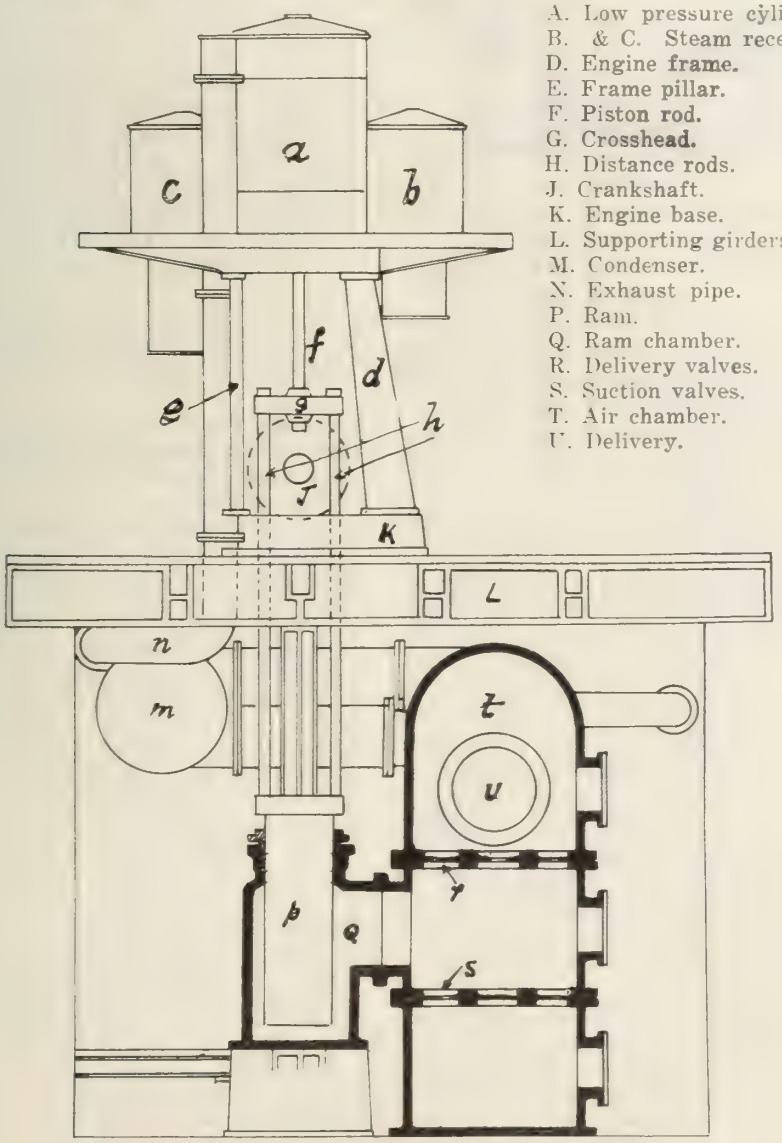


Fig. 1.

works engine now in use, the rotative and the non-rotative. The former as far as British practice is concerned generally takes the form of an inverted triple expansion steam engine driving three pumps direct from the crosshead. The engine is usually situated level with the engine room floor and the pumps with the condensing plant and other auxiliaries situated below it. This type of engine is also built in America, but the horizontal type, having the flywheel in between the steam cylinder and the pumps, is rather more popular in that country and receives little recognition in England. In a few isolated cases however, horizontal engines are found with the pumps behind the cylinders, the whole arrangement being much on the lines of the orthodox slow speed air compressor. There are, of course any amount of other practical arrangements such as vertical engines with horizontal pumps (the angle arrangement); pumps driven from an extension of the engine crankshaft; the rocking lever system, etc., all of which will be referred to.

The non-rotative pump, as its name implies, has no crank or flywheel. It is really a refinement of the duplex pump used for a variety of purposes. The ordinary duplex pump with plain slide valves and simple cylinders, is little used for waterworks duty. It is notoriously wasteful of steam, and compounding does not greatly improve matters. Some years ago, however, Worthington reconstructed this pump beyond all recognition, by the introduction of Corliss valves, compound and triple expansion cylinders, and other improvements, including the compensating device.

The Davey system of non-rotative pump has also been largely installed. It also has compound and triple expansion cylinders with a compensating device, but whereas the Worthington is a two-line engine, having two sets of compound or triple cylinders side by side, the Davey engine is a one line engine only. The latter is now losing favour for a variety of reasons, preference being given to the expansion rotative type by British engineers.



A. Low pressure cylinder.
B. & C. Steam receivers.
D. Engine frame.
E. Frame pillar.
F. Piston rod.
G. Crosshead.
H. Distance rods.
J. Crankshaft.
K. Engine base.
L. Supporting girders.
M. Condenser.
N. Exhaust pipe.
P. Ram.
Q. Ram chamber.
R. Delivery valves.
S. Suction valves.
T. Air chamber.
U. Delivery.

Fig. 2.

The non-rotative type, especially the Worthington engine, occupies less floor space than the rotative type, although the saving is not very marked. If well designed its efficiency is high, but it cannot be said to be as high as that of the best rotative engines of large size, and the mechanism is more complicated. Most of the recent engines installed have been of the latter type and there would appear to be, after all, little if any advantage to be shown by the non-rotative except in special cases.

The Steam Engine. Its General Arrangement in British Practice

The general arrangement of the steam side of a modern waterworks engine of the rotative type usually takes the form of three cylinders. These are mounted on the usual cast iron frame or columns and attached to a heavy bed plate all of which bear a close resemblance to the orthodox marine engine. The details, however, are usually not very different.

The slide valve or piston valve is not very often used on these, being almost invariably of the Corliss type although not necessarily so. Eccentric drive from the main shaft may serve to operate them, but a revolving gear driven way shaft is quite common. The Corliss valve is peculiarly adapted to this class of engine. Combined with steam jacketted cylinders, automatic cut-off, and high pressure superheated steam, the Corliss valve engine is capable of the maximum efficiency. Three cylinders are generally used, but there are cases where a compound engine would serve the purpose equally as well as a triple expansion and cost less to build. With compound cylinders the flywheel and pumps are usually arranged according to American practice. The vertical engine must have at least one flywheel, but sometimes there are two and even three. One of these may be toothed or racked for working in conjunction with a steam barring engine, or ordinary hand turning device. Governing is effected as a rule by the ordinary form of centrifugal governor acting on the cut-off of the h.p. valve, and which may be combined with some form of hydraulic governor. Surface condensers are invariably installed. It is usual to pump part or even the whole of the water raised through the condenser, doing away with a circulating pump and any necessity for cooling towers. The air pumps are usually worked off the main engine, although independent ones might be installed in special cases.

Failure of a public water supply would be absolutely disastrous to any large community, therefore the first essential is reliability. Efficiency from a coal consumption standpoint is of course most necessary seeing that water must be a cheap commodity, the cost of which falls on the community at large. It must also be remembered that these engines usually work continuously, and even the smallest waste in steam repre-

setting additional fuel consumption, may, over a period, amount to a considerable sum. Efficiency and reliability must be the first consideration in the choice of an engine, and the slow speed, triple expansion engine, of the type used for waterworks without doubt fulfills this requirement.

A good example of a modern triple expansion rotative waterworks engine is seen in Fig. 1, which is a photo of a Worthington Simpson engine operating at the Hong Kong waterworks and wherein drop valves are fitted throughout. It must not be inferred from what has been said that Corliss cylinders are quite universal in waterworks engines. As a matter of fact Worthington-Simpson build several class of engines with drop valves, these valves being located in the cylinder covers and operated from a revolving way shaft. Three engines of this class have been installed at the Hong Kong waterworks, Tytum-Tuk section. The drop-valve engine was developed along with the Corliss when engine builders were making every effort to reduce steam consumption. It was largely used on high class mill engines before the introduction of the steam turbine. It has the same advantage as the Corliss valve in enabling the cut-off to be actuated by a trip gear.

It is, in fact, quite a good system for slow speed engine work.

Fig. 2 shows the general arrangement of the type of engine under discussion together with the pumps and other details. Referring to the lettering:

An alternative arrangement of the ram and valves, etc., is shown in Fig. 2A, having the same reference lettering. This arrangement of engine and pumps is now usually employed for the larger engines, ram pumps of this kind of course serving to force water to any desirable height. Where conditions warrant it, the distance rods may be longer than that shown, enabling the pumps to be placed some distance below the engine. With ram pumps there is a limit to the length of the rods on account of them being in compression. If well pumps of the bucket type were driven direct from the crosshead, the rods could if necessary be of considerable length. It is more customary to find these pumps driven by rocking levers, the same engine often driving a set of ram pumps.

Both the engines shown represent the latest practice of two of the foremost British builders, combining well-lift and surface force pumps which are an ideal arrangement from several points of view, and are frequently met with. Of course there are a wide variety of conditions which may be considered as more suitable to the non-rotative pumping engine, while several other arrangements for rotative engines are in common use. There is a quadruple expansion engine of this class working in Cairo, the fourth cylinder being placed above the middle one. This engine was made by Simpson's and although it follows waterworks practice very closely it happens to be installed for lifting sewage.

The angle system mentioned before is seen at the Barnet Well station of the Barnet Water Company. The High and

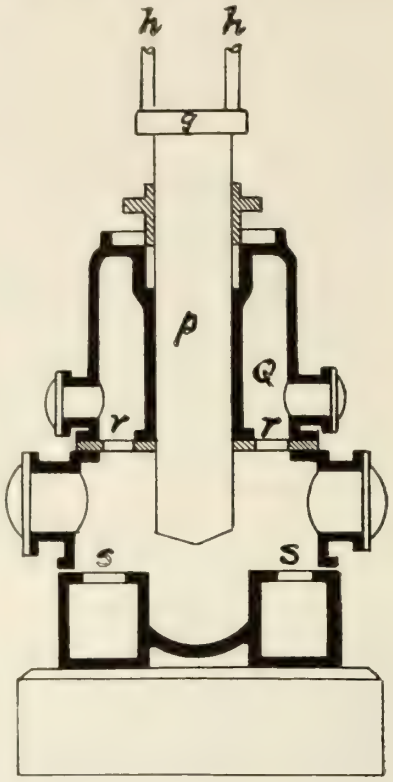


Fig. 2a.

Intermediate cylinders are vertical and the L. P. one is horizontal. There are two engines arranged over one well. Double bell-cranks are used to balance the work, also the long rods of the well-pump. Advantage is taken of this to arrange the cylinders and pumps so that the engine effort and pump resistance are directly distributed over all centres of the bell crank system in one plane, thereby ensuring great efficiency and steadiness in working. Corliss valves are employed and the pumps deliver 1½ million gallons in 24 hours to a height of 650 feet, of which 300 feet is from well to surface. At the Potters Bar Well, belonging to the same company, a horizontal tandem compound engine drives a double set of pumps also and raises half a million gallons to a height of 550 feet, of which 325 feet is well pumping. It is quite a small Corliss engine of under 100 h.p. but it gave a duty of 18 lbs. of steam per pump horse hour which is a good enough performance for a small engine.

The engine at the Broadmead Well of the Metropolitan Water Board is a good example of a pump where floor space is limited. The main pump, which is operated on the double bell-crank system consists of two working barrels. These are arranged in line vertically, one above the other and hang down the bore hole from the main engine frame by a column of welded steel tubes which are in lengths coupled together with externally screwed sockets. The two buckets are worked by wrought iron rods connected to crossheads driven from the bell-cranks, the top bucket having twin rods, and the lower bucket one rod. The centres of the bell-crank system are in this case wholly utilized for the various connections uniting the engine to the water end, including that of the flywheel, and the whole being self-contained on the main frames. This engine has one steam cylinder only. Several other examples could be mentioned. Even the old arrangement of beam engine built on modern lines, cannot be considered as entirely antiquated. An engine of this description is to be seen at the Chatham and Rochester Water Works. It is a compound rotative surface condensing beam-engine with high lift and delivers 3.3 million gallons per 24 hours, the combined lift being 380 feet. The high pressure and low pressure cylinders have Corliss valves, each independently driven from a central wrist plate actuated by eccentrics receiving motion from a countershaft. There is a governor-operated trip gear, the cylinders are steam jacketed, and the receiver is fitted with tubes supplied with steam direct from the boiler to act as a re-heater. Both sets of pumps are bucket and plunger pumps worked by separate connections from the crankshaft end of the beam.

(To Be Continued)

Babbitting a Loose Pulley

When a pulley is to be babbitted on a shaft and in the position it is to occupy when finished, and the tight pulley is already in place and known to run true, the loose pulley may easily be located by means of the other. When using an arbor, first secure in a perfectly upright position, put a collar on it that will form a support for the lower face of the pulley hub. After the pulley is placed on seal the joint with some suitable material as cardboard, felt or putty. Before placing the pulley on, it is well to cover the shaft with a layer of thin oiled paper, winding the same with heavy cord in a spiral form, the helix running toward the centre of the hub in the direction in which the pulley is to run. The grooves left in the babbitt after pouring will serve as ample oil channels and will likewise tend to keep the lubricant in the bearing instead of throwing it out at the ends. Should it be advisable to locate the shaft in a vertical position, the alternative would be to level the shaft horizontally and using a plum line across the sides of the pulley. By this method it is necessary to use a sealed collar on each end and it is also suggested to use a pouring hole in the hub instead of an oil hole, as the latter would afterwards require to be drilled out.

Efficient Lubrication of Air Compressor

Good Body Oil Required—Destructive Nature of Carbon Deposit —Affects the Proper Operation of Valves—Danger of Vapor Ignition—Cleaning Compressor and Piping System

SECOND only to the mechanical construction the efficiency of an air compressor depends on the systematic lubrication of the reciprocating and other movable parts which come in contact with the air being compressed. The purpose of lubrication is to reduce friction to the lowest possible degree and minimize the carbonization of the oil. The element of friction is probably the most serious as this is the primary reason for using the lubricant. The oil selected should have sufficient body to sustain the weight of the moving parts and form a film that will effectually prevent the piston rings coming in direct contact with the walls of the cylinder. On the other hand the oil should not be so heavy that excessive power is required to overcome the viscosity of the oil itself.

Carbon Deposit

The accumulation of carbon deposit resulting from the carbonization of the oil takes on a sticky condition when first attaching itself to the bearing surfaces but after a time becomes hard and flinty. This objectionable substance adheres to the cylinder passages, on the valves and in the pipe lines and air receiver. The inefficient operation of most compressors may be traced to the sticking or partial closing of the valves caused by the presence of this carbonized scale.

Other factors may be responsible for the accumulation of carbon deposit, but those generally found are:—the use of unsuitable oil, such as that used for steam engine cylinders, an oil that decomposes easily and quickly in the heat of the air cylinder; the use of too heavy an oil where the excessive viscosity prevents proper atomization, thus remaining too long in a liquid state on the hot walls of the cylinder and quickly forming into sticky deposits of carbon; too great a volume of oil, as too much good oil may have the same effect as a smaller quantity of heavier oil. The protection of the air intake is very important, as the entrance of dust, especially from coal, is detrimental to the proper operation of the compressor.

Fire Hazard

Apart from the objections just mentioned the presence of carbon deposit should be guarded against on account of the hazard that is associated with it. Particles of carbon may be torn loose and becoming incandescent might come in contact with the vaporized oil, given off by the lubricant, and igniting, the resultant fire being great or small dependent on the amount of carbon and vapor in the piping and receiver. Danger from this source can be practically eliminated by systematic cleaning of the carbon deposit.

As the temperature of compressor cylinders is governed more or less by the pressure of the air therein, the consistency of the lubricant used should conform to heat requirements. At the final stage of compression the air that has entered at atmospheric temperature has been raised from two to ten times; for instance, when maintaining a pressure of 10 lbs. gauge the compressed air when on the point of discharge from the cylinder will have a temperature of 145 deg. F., while the final temperature at 250 lbs. gauge pressure will be about 750 deg. F.

Rise in Temperature

The following table gives the temperature in degrees F. for air compressed to pressures of from 10 to 250 lbs. per sq. in. These temperatures are for single stage compressors—when using two-stage units the final temperatures will be approximately half of that recorded for single stage.

Air Compressed to	Final Temperature
10 lbs. gauge	145 deg. F.
20 lbs. gauge	207 deg. F.
30 lbs. gauge	255 deg. F.
40 lbs. gauge	302 deg. F.
50 lbs. gauge	339 deg. F.
60 lbs. gauge	375 deg. F.
70 lbs. gauge	405 deg. F.
80 lbs. gauge	432 deg. F.
90 lbs. gauge	459 deg. F.
100 lbs. gauge	485 deg. F.
110 lbs. gauge	507 deg. F.
120 lbs. gauge	529 deg. F.
130 lbs. gauge	550 deg. F.
140 lbs. gauge	570 deg. F.
150 lbs. gauge	589 deg. F.
200 lbs. gauge	672 deg. F.
250 lbs. gauge	749 deg. F.

The above temperatures are not to be taken as absolute, as variations from those given in the table will occur when air cylinders are water-jacketed and from radiation. Under good working conditions the higher temperatures given may be less in practice, while heat may be greater when machines are working at high speed on light pressure. Given temperatures are especially useful in testing oils to determine their resistance against the formation of carbon when raised to high temperatures. These given temperatures, however, are not to be taken as limits establishing the highest allowable flash point for an oil that may be used safely in lubricating air cylinders.

Mineral Oil Best

The most suitable oil for the specific purpose of air cylinder lubrication would be a pure mineral oil of high quality, free from any animal or vegetable oil mixture. The oil should be carefully filtered. Oils that have an asphaltic base are to be preferred over those produced from a paraffin base, as no matter how carefully the oils may be filtered, a small portion of carbon content will remain. Carbon deposited from asphaltic base oils is of a fluffy nature and may easily be removed from the cylinder wall and valve seats, while that deposited from paraffin oils soon takes on a hard, flinty appearance and is difficult to remove.

When using paraffin base lubricant on medium pressure machines the physical test should conform to that given in the table below:—

Gravity, Baume ..... 25 to 30 deg. F.
Flash Point (open cup) 400 to 425 deg. F
Fire ..... 450 to 475 deg. F.
Viscosity (Saybolt) at 100 deg. F. ..... 230 to 315 sec.
Color ..... Reddish
Congealing Point ..... 30 deg. F.

Oil having the above test figures is generally recommended unless a compressor manufacturer specifies that a high flash point lubricant should be used to meet the conditions peculiar to that particular machine. The possibility of carbon deposit is more likely from high flash point oil.

Asphaltic-Base Oil

For the selection of a suitable asphaltic-base lubricating oil the table below has been compiled. The figures given are for average working conditions.

Gravity, Baume ..... 19.8—21 deg. F.
Flash Point (open cup) 315—335 deg. F
Fire ..... 370—400 deg. F.
Viscosity (Saybolt) at 100 deg. F. ..... 275—325 sec.
Color ..... Pale Yellow
Congealing Point .....—0 deg. F.

When compressors are first installed they require a greater volume of oil owing to the character of the friction surfaces, but after the walls of the cylinder become smooth the quantity of oil may be reduced to avoid the possibility of carbon deposit. No more oil should be used than can be absorbed for adequate lubrication. Too much may be as destructive as too little.

A leading authority on compressor engineering contributes the following: "The best way to determine the proper amount of lubrication is to take out the valves from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry, the lubricators should be adjusted to feed a little more oil, whereas if oil lies in the cylinder and its parts show ex-

(Continued on page 28)

The Commercial Economy of High Pressure and High Superheat in the Central Station

By GEO. A. ORROK
New York, N.Y.

IN this age of progress when the designers of central stations of all types and kinds are vying with each other in the use of higher pressures and complication of the steam generator, prime mover, and auxiliaries, it is expedient to go back to the beginnings of central station and by a review of the line of development to get a broad perspective of the field of power generation which will enable us to apply, to newer developments, those basic principles of commercial economy and efficiency necessary to a proper solution of the problem.

The earlier use of steam when its expansive force had not been discovered, is best shown by the Newcomen pumping installations, in which the steam was used at atmospheric pressure. Watt discovered the expansive force of steam and so improved the boiler, engine and steam piping that 15 pounds gage could be used economically. From his time until about 1900 rising pressure kept pace with improvements in materials and in the design and construction of steam generators and piping, with occasional excursions into the realms of higher pressure and temperature. Practice at this date (1900) may best be illustrated by the work of the Wildwood engine. Since 1900 improvements in steam generators, piping, and prime movers have been made with increasing rapidity, and many modern plants are running on 250 pounds and 200 degrees of superheat, using standard piping and valves with the newer designs of boilers, superheaters, and turbines. Table 1 shows the pressures and economies theoretically possible and attained in a central station, with all the results reduced to British thermal units in the coal per kilowatt hour of useful work.

TABLE 1—STEAM PRESSURES AND ECONOMIES THEORETICALLY POSSIBLE AND ACTUALLY ATTAINED IN CENTRAL STATIONS

Year	Engine	Pressure, lb. per sq. in.	Temperature, Deg. Fahr.	Thermal Efficiency, Carnot cyce per cent	Actual B.t.u. per kw-hr	Actual overall thermal efficiency per cent.
1700	Newcomen	15	212	2.7	416,000	0.82
1810	Watt	30	300	9.17	61,000	5.6
1900	Wildwood	215	400	20.8	19,200	17.75
1922	Modern	265	650	35.00	18.000	19.00

Our engineers are now using better and more uniform materials than ever before. Our metallurgical and manufacturing methods have been greatly improved. Copepr, wrought iron and cast iron have been discarded for boiler purposes. Steel and even alloy steel are in common use and their uniformity leaves little to be desired. Certain of the non-ferrous alloys are in common use and play their part in aiding the common security which characterizes modern installations. Copper boilers and 212 degrees maximum temparture gave place to wrought-iron boilers and 30 to 40 pounds pressure with a maximum temperature of 300 degrees. The use of steel as a boiler material raised the pressure to 200 pounds and the temperature to 400 degrees, while our modern steels allow pressures up to 400 pounds with a maximum temperature of 750 degrees. In certain distillation plants temperatures as high as 1,100 degrees have been obtained, but the life of the material is short.

Now it is well known that steel when heated to comparatively low temperatures, say, 900 or 1,000 degrees, loses its strength and becomes unfit to sustain loads, and the heat strains from even moderate heating of 300 or 400 degrees may cause certain deformations of a highly unsatisfactory character. Cast-steel valves have deformed at 750 degrees to such an extent as to render them useless, and the "growth" of ordinary cast iron at temperatures above 450 degrees is known to be destructive; but notwithstanding this the later constructions at 250-300 pounds pressure and 700 degrees maximum temperature are commercial. The first cost is not excessive, repairs are moderate, and the life of the installation is all that can be desired.

Commercial Limits of Pressure and Superheat in the Central Station

What, then, are the commercial limits of pressure and superheat in the central station? In Fig. 1 we have calculated and plotted the theoretical thermal efficiency of the Carnot cycle, the Rankine cycle, and a regenerative cycle, using both saturated and superheat values for ranges up to 1,200 pounds and superheats of 750 degrees and above. It will be seen that the chosen regenerative cycle for saturation follows very closely the efficiency of the Carnot cycle, while the Rankine cycle falls below the Carnot cycle increasingly with rise of pressures. The superheat lines for both cycles are nearly parallel and maintain this characteristic over a wide range. The gain from regeneration increases with pressure and is constant for equal superheat. For any final temperature the gain from pressure increments decreases, but gain from regeneration increases with pressure increments. Thus at 750 deg. final temperature the Rankine efficiency increases from 33.5 per cent. to 40.5 per cent. with pressure rise from 200 to 1,200 pounds,

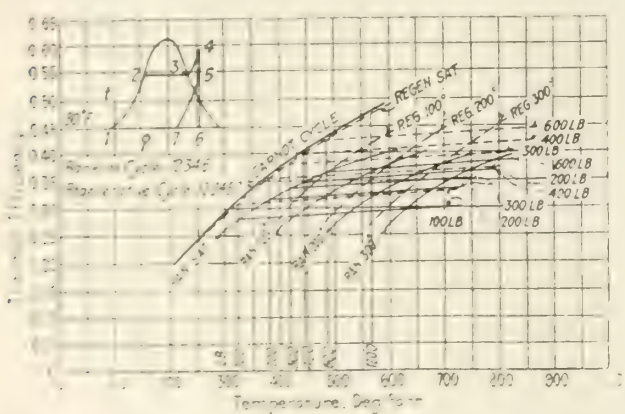


Fig. 1—Theoretical thermal efficiency of the Carnot & Rankine Cycle and a regenerative cycle using both saturated and superheat valves for ranges up to 1200 lb. and superheaters of 750 degrees and above.

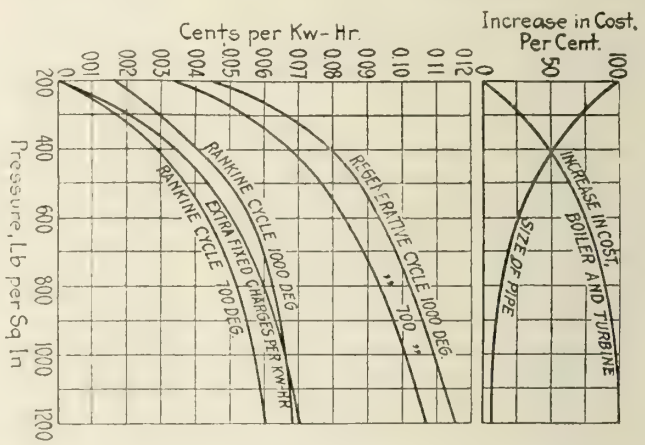

Cents per Kw-Hr.
Increase in Cost, Per Cent.
Pressure, Lb per Sq In
RANKINE CYCLE 1000 DEG.
RANKINE CYCLE 700 DEG.
REGENERATIVE CYCLE 1000 DEG.
" " 700 "
EXTRA FIXED CHARGES PER KW-HR
INCREASE IN COST, BOILER AND TURBINE
SIZE OF PIPE

Fig. 2—Saving in cents per kilowatt-hour for all conditions over the Rankine Cycle at 200 lb. and 700 Deg. maximum temperature based on $6.00 coal.

while the regenerative efficiency increases from 37 per cent. to 48.5 per cent. with the same pressure increase.

Fig. 1 dealing with theoretical efficiencies only, does not show the station losses which aggregate around 45 per cent. Grouping the losses, we may say that the generator efficiency is 97 per cent., turbine efficiency 78 per cent., boiler efficiency 80 per cent., leaving for auxiliaries, piping, and radiation 91 per cent., all of which multiplied together give 55 per cent. efficiency.

TABLE 2—SAVINGS EFFECTED THROUGH INCREASE IN STEAM PRESSURE.

Case	Cycle	Pressure lb.	Max. temp deg. Fahr.	Theoretical efficiency, per cent	Station efficiency, per cent	Actual efficiency, per cent.	B.t.u. per kw.-hr.
1	Rankine	200	750	33.5	55	18.4	18,500
2	Rankine	1200	750	40.5	55	22.3	15,300
	Saving			21.			3,200
3	Regenerative	200	750	37.	55	20.35	16,800
4	Regenerative	1200	750	48.5	55	26.7	12,800
	Saving			33.3			4,000

Table 2 shows how these figures work out for the above suppositions. The saving by regeneration when using 200 pounds pressure (Case 1—Case 3) is 1,700 B.t.u., and when using 1,200 pounds pressure (Case 2—Case 4) is 2,500 B.t.u. Considering the trend of the curves in Fig. 1, on this page, comparatively little is gained by further superheating, but there has been no attempt to go above 800 degrees, and the flattening out is much more marked as the temperature increases.

Water has its critical temperature at 704 degrees and the critical pressure is about 3,200 pounds. Pressures up to this limit may therefore be considered, and since oil-still temperatures up to 1,100 degrees have been used, we may consider superheat temperatures up to that point. We know that the first allotropic change in steel occurs at about 1,300 degrees, and 1,100 degrees is well below this point. Here, however, we must look into the physical properties of the steels used in power-plant construction.

When steel is heated the first sign of change—a dull red just visible in the dark—apepars at about 750 deg. Visibility in daylight begins at about 850 to 900 degrees and a full dark red is attained at about 1,100 degrees. The full cherry red is attained at the first allotropic change of 1,300 degrees. Good boiler steels increase in tensile strength up to about 600 to 700 degrees and lose much in ductility, but above 800 degrees the tensile strength rapidly falls off and the ductility largely increases. Cast steels of proper carbon content and suitable for fittings, valves, and turbine construction show the same properties within rather narrow limits. Pipe steels have nearly the same characteristics, but the temperature at which the tensile strength starts to fall is around 550 to 600 degrees. This lack of ductility or increase of brittleness at the maximum temperatures of use must be compensated for by a larger factor of safety (i.e., increased thickness and weight with higher cost) and a more careful selection of material. But with increased thickness it must not be forgotten that the safe stresses must be correspondingly lowered.

Variation of Strength of Materials with Temperature

This subject may be considered from five points of view, depending on the conditions under which the materials are to be used.

(a) Boiler Material.—Here we know that the maximum temperature cannot exceed 704 degrees, the critical temperature of water, and that the fire side of the tube or drum can only be a few degrees hotter. If 1,200 to 1,800 pounds per sq. in. be the chosen pressure the water temperatures is 625 degrees at maximum and the fire side will not exceed 725 degrees normally. This temperature is well within the maximum-strength zone, and only care is needed to secure sufficient ductility.

(b) Superheater Material.—The maximum temperature of the inner surface of the tubes may be a little higher than the maximum superheat. The outer temperature depends on the position in the boiler. Radiant-heat superheaters are now commercial where the pressure parts are protected with a heat-absorbing and conducting covering of cast iron. The fire surfaces may be 1,400 degrees to 1,600 degrees while the inner-wall temperature is as low as 700 degress, but 1,100 degrees is comparably easy of attainment. Bare-tube superheaters would have a maximum outside temperature of around 1,200 degrees, but the life at this temperature is unknown. The maximum safe point may be taken as 800 degrees superheat temperature and 950 degrees outside temperature.

Neither the tube manufacturers nor superheater manufacturers are afraid of these conditions, and I believe they are prepared to guarantee their product under such conditions.

(c) Piping Material.—Under this category the condition is markedly different. The steam side of the pipe is below the maximum temperature of the steam. The outer surface is much lower and the thickness of the material can be increased to compensate for the lower elastic limit of the material. The ductility is improving with temperature increase. Pipe joints are the only serious trouble, and the modified Van Stone joint with the pipe edges welded for tightness is the apparent solution. Experience with this joint has been satisfactory.

(d) Valves and Fittings.—Valves and fittings must necessarily be made of castings, and the low-carbon, openhearth steel used, while falling off in strength sooner than the worked material used in boiler and piping, has still a respectable elastic limit at 1,100 degrees. As in the last category, the inside wall temperature is lower than the steam temperature, with still lower temperatures at the outerwall. But the shape of the casting is all-important. Globe valves of the double-beat or Wanick type can be made with practically no flat surfaces and with two axes of symmetry. Internal pressures do not seriously deform this design, but external strains may cause minor troubles. Throttle valves and marine stop valves are usually of this type and can be kept tight at 750 degrees. It is probable that a temperature of 1,100 degrees could be safely undertaken with these valves if special precautions were used in the design of the seat, disk, and stem. Flexible-disk, double-beat valves are used in Europe at temperatures in excess of 750 degrees.

Gate valves have only one axis of symmetry and flat surfaces of considerable size. Here seat and disk troubles are encountered at temperatures above 700 degrees, and it may be some time before the manufacturers can guarantee a tight job at the higher temperatures. This type of valve is peculiarly sensitive to outside strains tending to deform the seats and disk.

(e) Turbine High-Pressure Ends.—Pressures can make little difference here as the high-pressure parts are comparatively small and without doubt the pressure will be reduced 50 per cent. in the first nozzle. There need be no high pressure stuffing box, so that the highest pressure to be packed against will be about half the maximum. Temperature strains will be the only thing that need be considered, and the expansion will reduce the superheat in the first-stage nozzle to a workable value, which is 750-850 degrees. It is to be noted that steam-chest or nozzle-box troubles have been the only prominent troubles where 400 pounds and 750 degrees superheat have been tried out, and it thus appears that a proper design will obviate most of the trouble. Cast or forged steel must be the material used.

In general, the turbine designers say that 1,200-1,500 pounds pressure has no terrors for them and can be used when desired. They can supply the apparatus. Temperatures are more troublesome and no one apparently cares to go much above 700-750 degrees at the present time. Superheater and valve materials at present seem to be the deciding factor in the use of high pressures and temperatures, and there is apparently very little which careful design and the selection of proper materials will not overcome.

Only a portion of the central-station installation is affected by high pressures and temperatures, especially where electric auxiliaries are used. The boiler and piping system and prime mover cover the entire list, and in the usual central station this has represented about 40

per cent. of the entire installation cost. Latterly, with the larger station the percentage is around 30, and may be taken at 25 per cent. for the newer and larger stations of which Hell Gate and Calumet are types. If the station cost be taken at $100 per kw. as an average figure this portion of the installation has cost $25, and at 15 per cent. the fixed charges are $3.75 per year or on 5,000 hours' use 0.07 cent per kw. hr. What, then, will be the extra cost of this apparatus when designed for higher pressures and temperatures? Standard boiler to-day can be bought up to 275 pounds pressure; 300 pounds necessitates thicker plates and tubes, and prices advance accordingly; 400-pound boilers have been purchased recently and 500-pound boilers have been built. Flash boilers of the Serpollet and De Laval types using pressures in excess of 1,200 pounds and coil boilers of the Herreshoff type using equally high pressures have been built as experiments or in toy sizes as for automobile work or for high-speed launches. Schmidt's water tube boiler working at 900 pounds has been run 14,000 hours with marked success. Boilers for 400-pounds pressure have been offered at about 50 per cent. increase in price and 1,200 pound boilers have been figured at a 100 per cent. increase in price.

Turbine designers are at work on designs arranged to utilize higher pressures, but higher temperatures seem more troublesome to them. I have no estimate, but we can safely apply the same percentage increases of price to the turbine that obtain with the boiler. Steam piping decreases in size with increasnig pressure so much so that it is doubtful if a 1,200-pound steam line would cost more than a 200-pound line of the same capacity. The volume of high-pressure steam at 1,100 degrees maximum temperature is quite uncertain, but the chances are that our figures are not more than 10 per cent. from the truth.

Summary

We may then summarize as follows:

a Pressures up to 1,200-1,500 pounds at least are commercial and may be attained without serious difficulty.

b Temperatures for the present are commercial up to 700-750 degrees, which should not be exceeded until our materials for valves and superheaters are improved. More extended experience is necessary before the range of 800 degrees and over is attempted in a commercial installation.

c With the completion of the Steam Table Research it will be possible to calculate accurately just where the possible limits of economy in pressure and temperatures may be located. At the present time the uncertainty of all values above 200-pounds pressure and 4,000 degrees Fahr. temperature render most of our calculations of only academic value.

d There still appears to be more economy in a closer study of operation and construction losses—resulting in improving the efficiency of central stations installed in accordance with the present accepted canons of design—than in the attempt to widely increase the temperature range of our heat cycles. While we may save 400 B.t.u. per kw.-hr. by using a regenerative cycle and increasing pressure and temperature, it should be possible to save nearly as much by a reduction to the lowest limits of the heat losses which we know exist in our present installations.

TABLE 3—SAVINGS IN COAL.

Pressure lb.	Temp. deg. F.	Rank eff.	Reg. eff.	Rank B.t.u.	Reg. B.t.u.	Rank B.t.u.	Savg over R 200 lb. 700 deg. B.t.u. per kw. hr. Reg. C.	Rank C.	Saving in lb. coal per kw. hr. (13800 B.t.u.) Reg. C	Rank C.
200	700	53.5	37.	38.4	20.3	18.35	16820	18620	1800	—	0.13	———
400	700	53.5	41.2	36.3	22.6	19.95	15100	17120	3520	1500	0.225	0.109
600	700	53.5	43.5	38.	23.9	20.9	14300	16350	4320	2270	0.313	0.1645
1200	700	53.5	47.5	40.	26.1	22.	13100	15500	5520	3120	0.40	0.226
200	1000	63.	38.	35.	20.9	19.25	16350	17750	2270	870	0.165	0.065
400	1000	63.	42.8	37.6	23.5	20.7	14500	16500	4120	2120	0.299	0.1535
600	1000	63.	45	39.5	24.7	21.7	13820	15720	4800	2900	0.348	0.21
1200	1000	63.	49.	41.5	26.9	22.8	12700	14970	5920	3650	0.43	0.257

Savings of Regenerative Cycle

In Table 3 we have given for 700 and 1,000 degrees maximum temperature and for four pressures the theoretical efficiency of the three cycles used, the practical efficiency of the Rankine and regenerative cycles, and savings per kilowatt-hour for all conditions over the Rankine cycle at 200 pounds and 700 degrees maximum temperature in B.t.u. and pounds of coal of 13.800 B.t.u. content.

In Fig. 2 these savings are plotted in cents per kilowatt-hour on the basis of $6 coal, together with the extra-fixed-charges curve. At the top of the figure are two curves showing the percentage increase in cost of boiler and turbine and the decrease in size of pipe required for a given quantity of steam. It will be seen that the extra fixed charges are always greater than the coal saving for the Rankine cycle (ordinary operation) at 700 degrees maximum temperature, and that the additional gain for the 1,000 degrees maximum temperature barely exceeds the additional fixed charges. We cannot then expect much from increasing pressures and the ordinary methods of using steam. Increasing temperatures help to some extent, but not enough to be attractive, since the saving is nearly all used up by the additional fixed charges.

With the regenerative cycle the results are much better and useful savings are indicated, increasing considerably with pressure and slightly with temperature. It is evident that some such regenerative cycle must be used, but the rewards from increasing temperature are not commensurate with the costs. Many regenerative cycles are possible, but the one used shows nearly the maximum economy. Such cycles need many heat interchanges and a number of separate feed pumps for the close approach to theoretical figures. Indeed, Thurston and Stanwood, in 1899 pointed out that with an infinity of heaters and pumps the Carnot efficiency might be equaled. So far, however, four or five stages have been the ultimate practical application, and not more than three have stood the commercial test. It would appear that considerably better design must be put in the apparatus if many steps are proposed, and also that more consideration must be given to the operating difficulties.—"Steam."

LUBRICATION OF AIR COMPRESSORS

(Continued from Page 25)

cessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times, the proper amount of oil can be determined to suit the characteristics of the particular lubricant used and the conditions under which the machine operates."

Regular Cleaning

No matter how high the quality of the oil may be periodical cleaning should be consistently carried out to keep the walls free of carbon. Different methods are used to perform this duty but few, if any, will surpass the results obtained from the use of soap suds having the consistency of one part soft soap to fifteen of water. This mixture should be fed to the compressor through the oil inlet at about ten times the speed of the oil. This practice is advisable at least every two weeks, and during the process the air valves should be inspected to see the effect of the cleaning process and to act as a guide to the operator as to the quantity of solution to use. The machine should not be left after cleaning until it has been operating again for some time with the regular feeding of lubricating oil. This is necessary to prevent the possibility of corrosion.

The power plant of the New Brunswick Electric Power Commission at the Musquash river hydro electric development operations has been completed under the direction of C. O. Foss, chief engineer of the commission, and Dr. E. A. Smith, the chairman of the commission.

VALVE SEAT FINISHING TOOLS

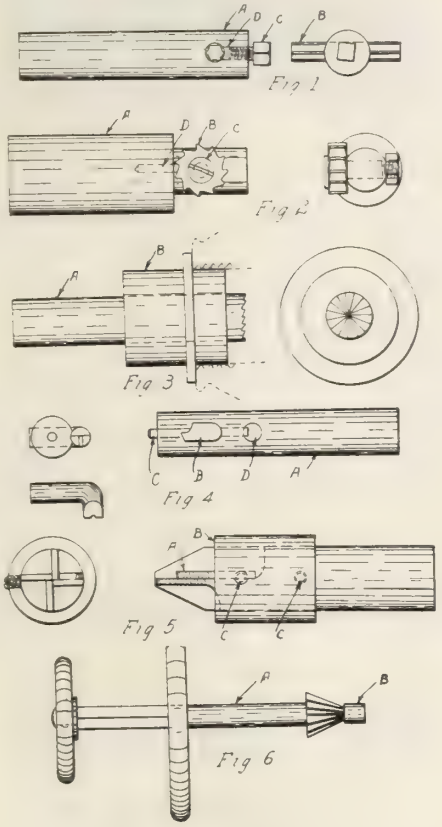
By Harry Moore

It requires two different tools, a rougher and finisher, to produce a good valve seat, although admittedly, very often, one tool only is used on this operation, the seats produced by the one tool method cannot be correctly termed good; at any rate not when the tool has been in use for any length of time. To state that a good valve seat must be smooth and uniform is to say something that everyone already knows, but the description of a few finishing tools designed to ensure this very necessary smoothness and uniformity will perhaps be of interest to many whose experience has not yet included this particular line of work. It should be understood the subject is herein treated as a manufacturing one, with particular reference to work of medium size.

Taking flat seats first, the principal troubles encountered are usually the difficulty of keeping the seats actually flat and the annoyances connected with chattering, which once started are so difficult to stop. A very effective flat seat finishing tool is shown in Fig. 1. The shank A is drilled through at one end to take the fluted tool B which is tightened in place by screw C bearing on the Vee pad D. The length of B is such as will allow it to enter the bonnet hole in the valve and the diameter of A is equal to the diameter of the valve seat hole and so pilots the tool when cutting. A perfectly flat, smooth seat is produced by this tool when properly made, and all six cutting edges can be used before regrinding is necessary, which, since the tool is only used for finishing and consequently does not have to remove much metal, is not very frequent. The flat seat tool shown in Fig. 2 is for use on what may be called exposed seats, that is, seats made on the surface of work—the bosses on machine castsings furnishing a good illustration of what is meant. The shank, A, may be made any convenient size, but the front end is, as before, made to enter the valve seat hole in order to steady the tool B which is a circular piece held on a screw C passing through the shank at right angles. A pin D, is driven into the shoulder of A to prevent the tool moving under the cut. The same advantage of several cutting faces is presented in this tool.

Fig. 3 shows a simple rectifying tool for reseating flat seats, which have, for this purpose, been returned for some reason or other. It is out of the question, of course, to rechuck such returned valves in the special chucking fixtures used on this kind of work, but with the aid of such a tool as shown a valve can be reseated in exact alignment. Part A is held in the chuck of a speed lathe, and B, which is a running fit on A, is gripped in one hand while the machine is running and the valve bonnet threaded opening pushed onto it up to the shoulder. A and B thus practically take the place of the valve stem and bonnet, and when the valve is pushed up against the cutting edge of the reseat will be exactly in line with the working parts.

A raised seat finished tool is shown in Fig. 4. This is used, together with a flat roughing tool, on brass castings. The flat rougher has a concave groove cut out on both sides of the cutting face, but the finishing tool has but one cutting edge as shown and better seats have been made than with a double edge



Valve-Seat Finishing Tools.

tool. The shank A is drilled at right angles for tool B which is made of drill rod bent as shown, the best cutting edge nesting in a shallow groove cut in the side of A. A pin C driven in the shank from the end holds the tool snugly in place and is driven out when required from hole D at the other end. By making up a dozen tools at a time they are produced at small cost; the shank A being hardened, is used as a jig for drilling the pin holes.

A common type of angular valve seat finishing tool is shown in Fig. 5; with an auxiliary tool for removing the objectionable burr thrown up by this in operation. As shown, one flute is milled further along than the rest and a flat piece of steel A is laid on the face and held in place by a collar B tightened by screws CC. A is adjusted in or out to slightly chamfer the top of the seat and being used only for this purpose can be kept with a very keen edge. In the last figure a hand finishing tool is shown for use in cases where the work cannot be brought to a machine. Although shown with an angular seating tool the same idea can be used of course on any shaped seat. The tool itself A, is squared on the shank for about half the distance and an ordinary valve wheel driven on to the end of square. A turned down portion on the end carries a smaller wheel, resting on a washer at one side and riveted over at the other, care being taken to leave the wheel a running fit. Different sizes of pilots B are used to take care of various sizes of valves and the tool is made to cut by turning the big wheel with one hand and applying pressure on the small wheel with the other. With proper fitting pilots this tool produces a well finished seat, very little pressure being required.

MOUNT ROYAL HOTEL IN JAN. 5TH POWER HOUSE

An outstanding feature of the Jan. 20th issue of Power House will be a carefully prepared detailed description of the power plant in connection with the new Mount Royal Hotel at Montreal. Descriptive details will be given with reference to the following items:

1. Methods of delivering coal at the hotel; weighing before placing in storage; handling and conveying to boiler room; coal hoppers, and the means whereby coal is weighed and distributed to stoker hoppers as required.

2. Steam generating equipment, including boilers, stokers, furnace linings and boiler fittings, also the ash hoppers, cars and hoist.

3. Pipe layout for distribution of steam and feed water system.

4. Boiler room auxiliaries, including boiler meters, gauges, feed-water pumps, heater and hot well tank supply.

5. Engine room steam electric generator outfits; also the motor generator sets.

6. Refrigerating engine and system.

7. Vacuum pumps and return taps; also air compressors.

8. Heating, direct and indirect; also the ventilating system.

9. Electric distribution system for illumination and power purposes, including the switchboard and instruments; also transformers.

10. Operating staff and maintenance.

This article should prove of unusual interest to all operating and designing engineers.

Steel work on the new office addition to be built on the the Montreal Tramways building on Craig St., Montreal, has been awarded to the Dominion Bridge Co. The structure will cost about $125,000.

Member of the Audit Bureau of Circulations

POWER HOUSE

A Semi-monthly Journal Dealing with the Power Plant Field, Steam, Electricity and Refrigeration.

TORONTO, DECEMBER 5, 1922

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Reviewing the Engineer's Position

IN TAKING over the editorial chair of Power House, I do so with a full realization of the responsibility I am assuming, on account of the very able manner in which this paper has been conducted in the past. This fact has been amply demonstrated to me during my short period of office by the number of congratulatory letters that we have received from our readers, expressing their appreciation of the subject matter that has been produced in its columns, and requesting a continuance of the same policy. One of the most notable of these, which is typical of the general feeling, is published under The Operators' Point of View in this issue, and which truly speaks for itself.

A letter such as this clearly demonstrates what can be done when a man has been inoculated with the "Interest" germ. The laborious daily work is converted into interest, and interest into enthusiasm. The boiler room is immediately transformed into a wonderful laboratory. Work loses its drudgery, and the process that you so oft have seen, becomes a beautiful experiment, with you, acting as the professor in charge.

It is when a man develops such an interest, that he has taken the first step towards success. Instead of working for his pay-cheque, he has something greater at stake. He is gaining an experience that will be invaluable to him later. With each experience, he is qualified to take a higher rung in the ladder of success, and so he slowly and surely ascends.

Unfortunately the war has had a destabilizing effect upon industry and labor throughout the world. Labor has been demanding and clamoring for the war-rate of pay, that it has long been accustomed to, and capital, on the other hand, striving for the higher percentage of interest. The situation is analogous to and can be fairly compared from a physics standpoint, i.e., action and reaction, and I think we can fairly say, that we are now nearing the end of the reaction stage. It is four years since the armistice was signed, and we can now naturally expect to see the situation assume a more normal aspect. The horizon is clearing and it will not be long before our factories are again humming and throbbing with life, and working again on full production. New extensions will be added and additional factories built. Then comes the time for reconstruction and it is to the engineer that all eyes will naturally turn.

It is the engineer that is the mainstay and the backbone of all industrial and commercial enterprises. Ask yourself where we would have been had it not been for the engineer during the war. Look back through the last century and see what the engineer has accomplished for civilization. Try and imagine into what chaos the world would be suddenly plunged if all the engineers were suddenly plucked from our midst, and it will give you a better idea of your position in the community.

When the time of reconstruction arrives, are you in a position to assume the responsibilities of the engineer in charge? If not, why? There will be quite a number of engineers who will suggest that they are lacking in experience. To them I would say, "Now is the time to get it." There are others who will suggest they have not had the university education. I remember a gentleman once defining to me the difference between the university and the self-taught engineer. He said, "One had learnt Latin and forgotten it and the other had never learnt Latin at all."

Now is the time to do the pioneer work, so that we will be in a state of preparedness to drop in on the big positions when they occur. Some of the ablest engineers I have met in this country have been self-taught men, and there is all the more credit due them for it. If there is perseverance and concentration of purpose behind a man's endeavor, the battle is three parts won, but, remember, education is the most essential requisite for all branches of engineering, and it is surprising what progress can be made by plodding.

It will therefore be my main endeavor to only include such subject matter in this paper that will be educational and instructive, to meet with the requirements of the power plant engineer. A number of educational series have been run through these columns in the past, which appear to have been highly appreciated. With a view to laying out my future programme, I would welcome any suggestion or constructive criticism that readers have to make, with a view to stimulating the interest in this paper, and, in so doing, I ask for your loyal co-operation and sympathetic support. I wish to contribute in helping to solve the problems that are ever confronting the engineer in his daily duties, and hope that my efforts will be made effective due to your sound directorship.

There are big opportunities ahead, and if you wish to be in a position wherein you can jump in when these occur, you must be prepared. Education is the only means of effecting this, and therefore my advice to all ambitious engineers, who wish to make any headway in their profession, is get the "Interest" bug.

The Season's Greetings

OUR QUESTION BOX

Questions are invited from readers regarding power plant operation and difficulties encountered

CHANGING ALTERNATOR

Question:—Would you kindly let me know through Power House if it is possible to change a 300 K.V. 2,200 volt. 2 phase generator into a 550 volt, 3 phase generator and how you would change the rotation of a 3 phase induction motor.—Huntsville.

Answer:—It is quite possible to change a 300 K. V. A. 2,200 volt, 2 phase alternator into 550 volt, 3 phase alternator.

The simplicity or not of effecting this change will depend on the type of winding at present on the alternator. Is it a rotating armature or rotating field type of machine, or is it a closed coil winding, or an open coil winding?

To obtain the precise layout of the proposed new arrangement of windings it will be necessary to know—number of slots on armature; number of coils per slot; number of poles, frequency and speed. With this information we can calculate the necessary phase displacement.

Let it be borne in mind that a 2 phase alternator is merely an alternator possessing TWO SINGLE PHASE windings, these separate windings being spaced 90 degrees apart. A 3 phase alternator possesses 3 single phase windings each 120 degrees apart, and simply one end of each of these 3 windings is connected together, either in star or delta formation.

It will be obvious that a winding that has given satisfaction on this 2,200 volts would also give satisfaction when working at a lower voltage In this particular case, we have to lower the voltage from 2,200 to 550. We shall therefore need to reduce the amount of the winding in the same proportion. Remember that a conductor has to cut 100,000,000 magnetic lines of force to generate 1 volt and seeing that none of the other factors, such as flux, speed, number of poles, etc., are to be changed, there only remains the number of conductors to be changed. If, however, we reduce the number of conductors, we will reduce the voltage generated, but if we desire the same amount of power as before, we shall have to increase the sectional area of the conductors to accommodate the extra amperage. This can be achieved by connecting the surplus number of conductors in parallel, until we have the necessary sectional area of copper required and taking great care that the means used to connect these coils in parallel are outside the densest part of the magnetic flux.

The reduction of voltage now having been accomplished, we still have to change the number of phases. If the alternator is one of the old style closed ring windings it is only necessary to divide this ring into three equal sections 120 degrees apart, and at that point carefully make a tapping, seeing this tapping makes contact with all the paralleled coils. Each of these tappings are then taken to their respective slip rings, of which there must be three. If, however, the winding is the more modern type, it will most likely be either lap winding or wave winding, and may be either a distributed or a concentrated winding. In such a case a great deal more care must be exercised in the phase displacement, as we need to take more care in the selecting of the coil pitch. In this case for 3 phase displacement, the total number of coil sides must be divisible by three, this being the number of phases. This results in a full pitch winding, as each coil will span the exact distance between the centers of the adjacent pole pieces. One end of each of the completed phase windings is brought to a common junction point, whilst the other ends of each phase are connected either to their respective slip rings, or to terminals on the alternator frame, according to whether the alternator is either a revolving armature or revolving field.

If such a method is chosen for connecting to a common point, it will be known as a star connected alternator.

Instead of connecting to a common point, however, these ends may be connected in mesh or what is more frequently termed delta.

Should this machine be star connected:

The voltage between any two collector rings equals voltage per phase multiplied by $\sqrt{3}$ or 1.732.

The current in each line equals the current in each phase winding.

Should this machine be Delta connected:

The voltage between any two collector rings equals the voltage per phase. The current in each line equals the current in each phase multiplied by $\sqrt{3}$ or 1.732.

The operation proposed, however, presents many technical difficulties, and should not be attempted unless considerable experience has already been acquired in a similar class of work.

To change the direction of rotation of a three phase induction motor, reverse any two of the wires connecting on to the motor terminals.

GEO. R. ARCHDEACON.

Dec. 13, 1922.

CLEANING CASTINGS

Question:—We would be pleased to have you advise us what pickling process would be best for removing sand and cleaning grey iron castings.—W. H. C., Montreal.

Answer:—One of the most common methods of removing sand from castings is to soak them over night in a solution of one part sulphuric acid (oil of vitriol) and 4 parts water. This is to be kept in a wooden vat, painted on the inside with white lead. If the solution is kept boiling by having steam pipes running through it, several batches can be pickled in a day. This solution is only good where the scale is soft enough to be penetrated by the acid, which attacks the surface of the iron, leaving the scale loose so that it can be washed or brushed off.

If the sand is burned right into the metal there is only one acid which will remove it. Hydrofluoric acid will eat sand, and if kept in a glass retainer, will dissolve the glass, but it will not attack iron, neither will it affect wood, so a wooden vat constitutes the entire equipment. If the castings are immersed for two or three hours in one part of hydrofluoric acid and ten parts of water, the metal will be freed from sand as well as the hard magnetic oxide (scale). This solution is equally as effective on forgings, and is by all means the best method known.

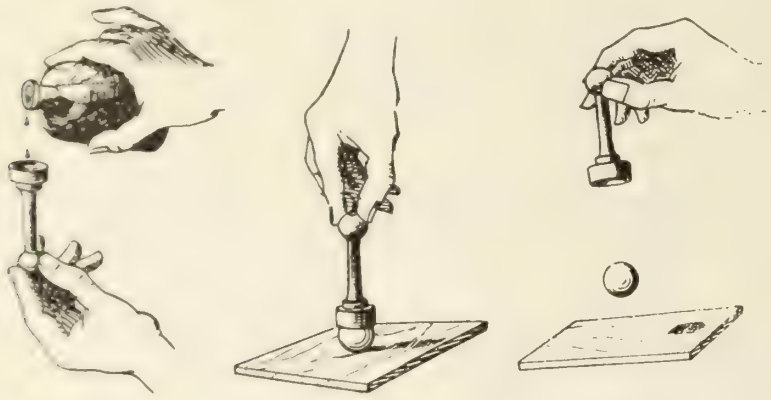
NEW BOOKS

Engine Room Chemistry, by Augustus H. Gill, S. B., Ph. D. Third Edition, 5 x 8 inches; 175 pages, published by the McGraw Hill Book Company, Inc., 370 Seventh Avenue, New York. The book is a comprehensive treatise on chemistry, dealing with combustion; the analysis of gas fuels, oils, feed-water and scale, and illustrated and explained in such a manner that it can be thoroughly understood by an engineer or boiler attendant. The 3rd edition is a revised treatise introducing a new chapter on combustion and bringing the book up to date.

Progress in New Equipment

THE MICHELL VISCOMETER

One of the most important tests determining the suitability of a lubricating oil for a given purpose is the viscosity test. The function of the oil in lubrication being to form a film between two surfaces sliding over one another and so prevent metallic contact, it is necessary to have a scale of measurement for viscosity, so that oil capable of forming this film may be obtained under any given conditions of temperature, pressure, speed, etc.



Hitherto the instruments employed have been of a kind suitable for laboratory use only; and, as most of them are based on the rate at which the oil runs through a capillary tube, the time occupied in testing, especially with a very viscous oil, is considerable.

This new instrument which we illustrate here measures viscosity on a new principle. The instrument consists of a cup of steel or cast iron having a perfect concave surface, and it is provided with a hollow stem or handle which forms a thermometer pocket extending into the metal of the cup. The surface of the cup has three minute projections, which prevent the steel ball from making complete contact and regulate the thickness of the film of fluid under test. To protect the concave surface from injury and to accommodate a surplus of the fluid, the cup is slightly recessed all around its edge.

In the workshop method of using the instrument two or three drops of the fluid to be tested are put into the cup so that when the ball is placed in position the gallery and annular recess are completely filled. The whole is then inverted and the ball and cup pressed firmly together on a clean board or pad to ensure contact between the ball and the projections on the cup. The method recommended by the makers is to rest the elbow on the bench whilst applying the full weight of the hand, i.e., 5 or 6 lb., on the knob of the instrument for a time, not less than half the time to the fall of the ball as determined by a trial reading. Pressure is then released for one second, and the Viscometer is raised an inch or so and held steadily in a vertical position. At the same time a stop-watch is started and the number of seconds from the lift to the fall of the ball is noted. The time in seconds divided by the constant of the instrument gives the viscosity of the fluid in dynes per sq. cm. at the temperature shown by the thermometer in the stem.

The principle of the action is briefly that the oil, by the preliminary pressure of the hand on the stem of the instrument, forms a film between cup and ball. On the pressure being released the oil film is no longer in equilibrium and a flow inwards is set up. The viscosity of the oil determines the rate of flow, and the rate of flow determines the time elapsing between the lift of the instrument and the fall of the ball.

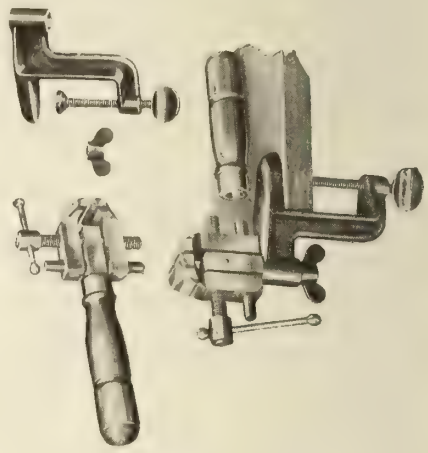
The viscosity thus obtained is the Absolute Viscosity, whereas with instruments of the capillary tube type the results have to be converted, by the solution of an equation, into Absolute units.

The method described above, whilst useful in classifying oils, is limited to the determination of their viscosities at atmospheric temperature. To find viscosities at different temperatures, the test with the Michell Viscometer is made with the instrument immersed in the fluid to be tested, the fluid having been raised or lowered to the desired temperature. This test is a laboratory test requiring more time and care than the method first described.

The constant given on the case of each instrument is that applying to the laboratory method of use, but this constant gives a degree of accuracy sufficient for use in the workshop test. The instrument is made by Michell Bearings, Ltd.

COMBINATION HAND VISE

A handy general utility combination hand vise has just been placed on the market. The use of a ball end handle for tightening the jaws instead of a wing nut is particularly worthy of note. By this means far more leverage is possible and thus a common difficulty in hand vises is eliminated. The hand vise is



furnished with a clamp permitting its use as a small bench vise on benches or shelves having an approximate thickness of ½ in. 2⅛ in.. As shown in the illustration the change is simply effected by removing the handle and substituting the clamp. When used with the clamp the vise can be adjusted to any point in a complete circle to meet the convenience of the user. The clamp is made purposely large and strong so that it will withstand hard use. The jaws are tempered and polished drop forgings 1½ in. in width. These tools are made by the L. S. Starrett Co., Athol. Mass.

Montreal—Boiler Equipment Company, Limited, are incorporated with $50,000 capital, to manufacture and market steam boilers, tanks and internal combustion engines, as well as contractors' equipment.

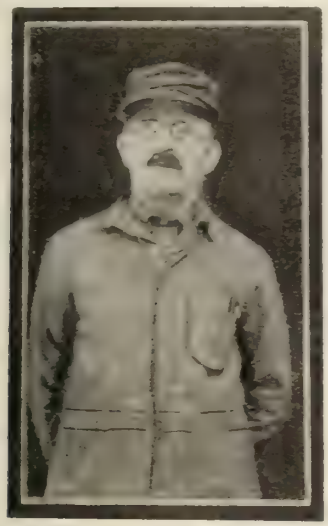
The Operators' Point of View

Acton, Ont. Dec. 4th, 1922.

Editor. "Power House," Toronto.

Dear Sir:—

I am glad to tell you personally that Power House has been, and is, a great help to me. It has made my work a pleasure and an interesting study instead of a coal shifting drudgery to be gone through each day, in a certain amount of misery, with long hours.



J. V. SAVAGE

What started me on the right road was your course of instruction for a higher grade certificate, published a little over two years ago. The first thing I learned, was the tensile strength of boiler plate, also the different riveted seams and the pitch of the rivets. Then came the difficulty of working out the formulas as I had forgotten all about fractions and sums. My interest was aroused and I was determined to go on, so I arranged with the Acton High School Principal to take me through the course, giving him $1 per hour for his help. After a few hours with him, everything became easy, and I cannot begin to tell you how thankful I am for what "Power House" has done for me. My work is now a pleasure, and whatever query my employer puts to me, I can answer him and prove my words in a technical as well as a practical way. I worked out two formulas in front of him last week in respect to an alteration in the plant I wanted to be made. Three years ago I could only have replied to his questions by gibberish and bull-shooting talk, and wonder afterwards if "It was a go," and wish I had thought to say something else instead.

Instead of burning three cars of coal last winter we only burned two, and since reading your articles published lately on combustion, I am on the road to better even that record.

I have no fault to find with "Power House" and as for ads, I think they are wonderfully instructive.

I hope you are not tired of this letter, but I am pleased to write to tell you how I appreciate your efforts for all stationary engineers and to my 60-year old self in particular.

J. V. Savage.

Mr. Savage first saw daylight in London, England, in 1863. At a very early age he became familiar with boilers and various equipment in a small factory owned by his father.

In 1913, however, he decided to seek his fortune in Canada, and after working with one or two concerns, he was in 1915 appointed engineer to his present company, Messrs. W. H. Storey & Son, glove manufacturers, Acton.

He is very proud of his plant, which consists of two boilers, a 25 H. P. single cylinder, non-condensing horizontal engine; one 15 H. P. gasoline engine; one 7½ H. P. motor and various other small equipment, all of which reflect in turn the master touch of a born engineer. He has a number of very ingenious contrivances about his plant, disclosing an original mind pregnant with ideas.

Mr. Savage is now studying for his 2nd Engineer's Certificate, and we trust through the medium of this paper, that we can be of still even greater assistance to him in enabling him to succeed in his new undertaking.

MACHINING PISTON RINGS

By John Magee

The majority of piston-ring manufacturers prefer to make rings with the finished surfaces ground to size. It is easier to hold accurate dimensions on a grinding machine than it is on a lathe. However, hard castings and hard spots in castings are machined without difficulty or detection by grinding. For this reason piston rings with a turned finish on the diameter dimension should be specified. Neither the scleroscope nor the Brinell hardness test will disclose hard spots in castings. A ground finish may cover up many hard spots or a hard scale. The production of a turned surface is a somewhat slower process for the manufacturer, but it guarantees a uniform soft wearing surface.

Flatness is very essential, since a serpentine condition will allow leakage around the back of the ring through the ring groove. If all of the internal stresses are not removed during the process of machining, the ring is apt to to warp sidewise. Therefore width dimensions should be inspected with a light gage instead of with a micrometer. With the ring lying on a perfectly flat surface, a side warp will cause it to register oversize. With measurements at intervals the two points of the micrometer might indicate a parallel width on a ring considerably warped.

The most common defect in the manufacture of piston rings is the elliptical ring, generally termed "out-of-round;" tolerance may vary according to the amount that the ring is likely to be worn in on the block. At best it is desirable to keep the variation within very low limits, say, 0.00025 in. to 0.00050 in. If the tolerance is expressed in light-gage terms it is much more simple for inspection, because the light gage is at present the most practical inspection device for locating out-of-round rings.

No accurate data are available for determining the poundage or wall pressure of piston rings to accomplish definite purposes. Actual experiments conducted at different times for different purposes seem to indicate that a poundage in excess of 4 lb. per sq. in. of bearing surface is needed to prevent collapse under pressure. Therefore a poundage of 5 lb. per sq. in. has commonly been specified for all purposes.

There seems to be a diversity of opinion as to the proper gas opening or expansion allowance. This is probably due to the difference in the estimated temperatures to which a piston ring is subjected. Using 0.0000056 per in. per deg. as the coefficient of expansion of cast iron, a minimum opening allowance for maximum expansion is obtained by multiplying this coefficient by the circumference of the ring.

A flattened strand wire rope seven miles long, without splice in either strand or rope, was recently produced at Birmingham, England. It is 4⅝ inches in diameter and weighs 73 tons. It was shipped in coils on specially prepared and connected railway trucks.

Practical Electricity for the Power Plant Engineer

By G. R. ARCHDEACON, A.M.I.E.E.

AS the last article was devoted to the general elementary laws governing the functioning of a dynamo, we may now proceed a little further with the consideration of the practical application of such laws.

As the loop of wire on the armature is rotated between the North and South pole of the dynamo, the magnetic lines of force are cut by this loop. When the loop is in such a position relative to the poles as to cut the maximum number of lines, so will the E. M. F. induced in the armature be a maximum value. Both before and after passing this critical position the E. M. F. will be reduced in value. We therefore have a condition wherein this is a constantly varying value, gradually increasing and decreasing.

There is, however, still another effect to consider. As the loop comes into the range of the magnetic lines of force from the north pole. the current induced into the loop will be in a certain direction, but when the loop comes into the range of the magnetic lines of force from the south pole, the current induced will flow in the opposite direction.

From this it will be seen that the direction of current flow is constantly alternating from one direction to another. This is known as an alternating current.

All dynamos and alternators generate an alternating current.

The only practical difference therefore between the alternating current machine and the direct current machine, is simply the effect of connecting a commutator to the armature winding.

The function of the commutator, therefore, is to pick up the current just at the moment it is about to reverse its direction.

The brushes resting on the surface of the commutator convey the current to the external circuit.

The main parts of a dynamo are:—

FIELD MAGNETS to provide a magnetic field.

ARMATURE to provide the E. M. F.

COMMUTATOR to provide a collecting surface for the current flowing round the armature.

BRUSHES.—To collect the current from the commutator.

FRAME to provide support for the magnet poles, and for the bearings.

FIELD MAGNETS.—In all commercial dynamos the field magnets are made up of electro-magnets, and not permanent magnets, formerly these following the conventional shape of a "horse-shoe magnet," with the winding located round the centre point. This is all ancient history now, as all modern machines, are what is termed multi-polar, and consist of numbers of pole pieces, such as 4, 6, 8, 10, 12, but always a multiple of 2.

These pole pieces are evenly spaced round the yoke or frame of the machine. These pole pieces are known as cores, upon which is wound the field winding.

In choosing the materials for these cores it is necessary to bear in mind the permeability of the metal chosen, cast iron, cast steel or wrought iron may be used.

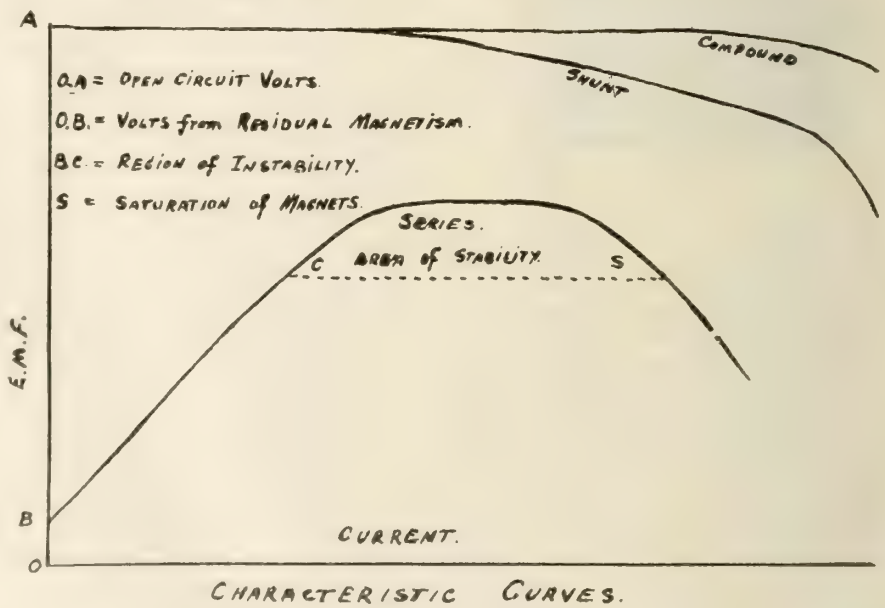
Wrought iron is most desirable, as it requires the smallest amount of material for a given magnetic flux. There is also a saving in copper due to using wrought iron, on account of its small size, the length of each turn of magnetising coil is reduced.

Cast iron is used because its cross section may be increased.

Cast steel appears to be intermediate between cast iron and wrought iron, but from the consideration of reluctance or magnetic resistance, wrought iron is the best material to employ.

For convenience in taking out the armature it is usual to divide the yoke into halves, the top half being provided with a strong eye-bolt, to permit of it being lifted up whenever necessary.

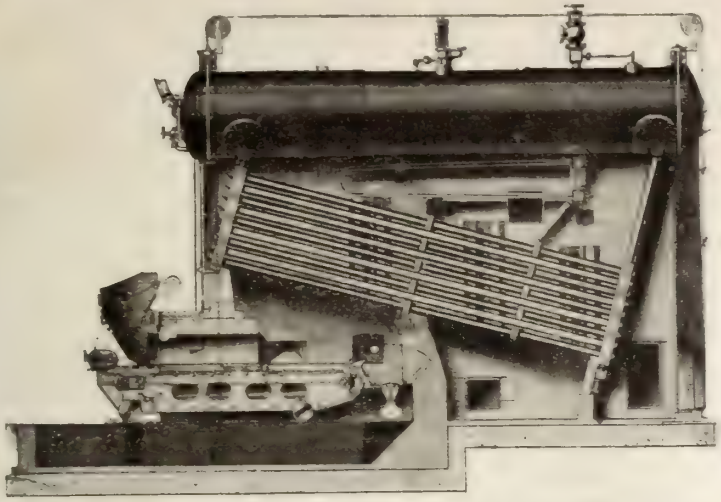
Unfortunately, however, this always results in an increase in the magnet resistance of the magnet circuit through the yoke, as no amount of careful fitting of the surfaces of the joint will make the connection as intimate as a solid mass.



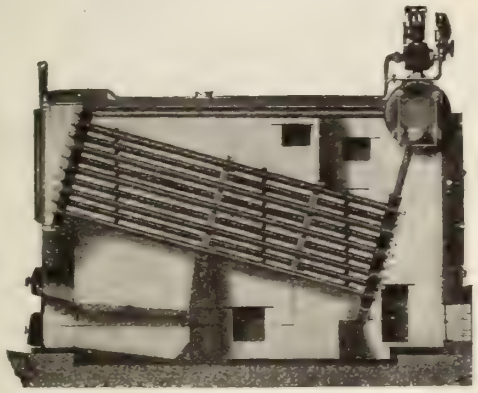
CHARACTERISTIC CURVES.

Any increase in the magnetic resistance results in a corresponding decrease in the magnetic strength of the pole, and needs to be compensated by the addition of several extra turns of wire in the field winding.

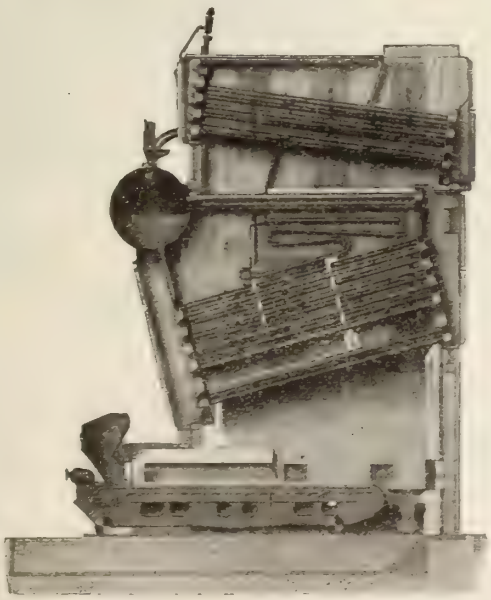
It will, therefore, be readily seen that should the permeability of the magnetic circuit be lowered, either through ill-chosen material, or bad contact in as-



W. I. F. TYPE—With chain grate stoker and superheater suitable for most purposes on land.



CROSS-TYPE—A most desirable form of boiler where headroom is limited.



MARINE TYPE—(For land purposes). The marine-type boiler is equally adapted for installation on Land and is especially suitable for electric generating stations and other quick steaming plants. Where ground space is limited, and expensive, it offers particular advantages.

EFFICIENCY DURABILITY SAFETY

THERE IS A TYPE

OF

B. & W. BOILER

TO SUIT EVERY CONDITION ALL HAVING THE SAME PRINCIPLES OF CONSTRUCTION, VIZ:—

Water divided into sections, no general explosion can occur.

Every section able to contract and expand without interfering with any other part of boiler.

Boiler as a unit can move without disturbing setting.

Positive circulation of the water keeps all parts at nearly uniform temperature.

Proper workmanship.

Materials which experience has shown to be the best for the particular purpose.

A great excess of strength over legitimate strain.

No joints or cast metal exposed to the direct action of the fire.

Perfect circulation of both water and gases. Proper proportions for work to be done at any rating.

Ample water and steam capacity and water space for disengagement of steam.

Scale forming materials and soot can be removed while boiler is working.

All parts readily accessible for cleaning and repairs.

Adaptable to any furnace burning any fuel, solid, liquid or gaseous.

No restrictions to draft.

QUICK STEAMING.

Write for Full Information

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LIMITED

ST. HENRY, MONTREAL

Toronto Office: Bank of Hamilton Bldg.

sembling that circuit, a greater number of ampere-turns will be necessary to obtain the required flux from the magnet, seeing that—

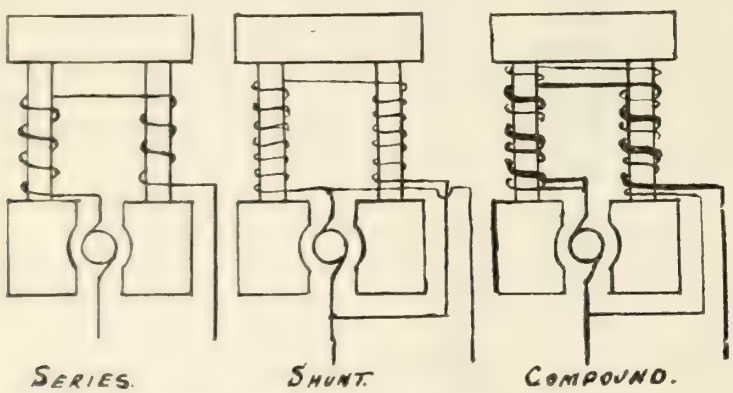
$$\text{Flux} = \frac{\text{Magneto-motive Force}}{\text{Reluctance}}$$

$$\text{Magneto-motive Force} = \text{Strength of Current} \times \text{Turns of Wire} \times 4\pi$$

$$\text{Reluctance} = \frac{\text{Length of Magnetic Circuit}}{\text{Area} \times \text{Permeability}}$$

$$\text{Ampere Turns to Produce One Line of Flux} = \frac{\text{Length of Magnetic Circuit}}{\text{Area} \times \text{Permeability}} \times .3132$$

The winding of the field coils is a comparatively simple matter, but care must be taken to see that the winding is in such a direction that it makes the pole pieces alternate north and south. To obtain this effect the winding on one pole piece will start at the face end of the pole, and terminate at the frame end of the pole, but the adjacent pole piece will have its winding starting at the frame end of the pole piece, and ending at the face end of the pole piece. By so doing the current will be flowing in opposite directions round each alternate pole, thereby changing the polarity of such poles.



FIELD WINDINGS.—There are three distinct forms of field windings.

(a) Series winding.

(b) Shunt winding.

(c) Compound winding.

Series winding, is a winding through which the total current supplied to the external circuit must pass, as this winding is in series with the armature. The coils must, therefore, be wound with wire of sufficient sectional area to carry the maximum current of the dynamo without over-heating, whilst at the same time it must also have the lowest possible resistance, otherwise there will be a serious drop in voltage.

Shunt winding is a winding through which only a fraction of the total current flowing in the armature is permitted to pass. The shunt winding being another circuit in parallel to the armature circuit, and of considerable higher resistance than the resistance of the armature.

Compound winding is a winding consisting of a series winding, and also a shunt winding on the same pole piece. The series winding consisting of only a few turns of wire of large sectional area, whilst the shunt winding consists of a great number of turns of wire of small sectional area. By correctly proportioning these two types of windings the machine can be designed to render satisfactory service under almost all conditions of load, and to be within certain limits automatically self adjusting.

Each of the above types of windings possess their own special characteristics, which may be briefly described as follows:

When the load on a series wound dynamo is small, the current flowing in the external circuit is of a low value. As this current must flow round the field winding, the degree of magnetisation of the field must of necessity be small, but when the load on the dynamo is great, a considerable amount of current is flowing round the field winding and on into the external circuit. Such an increase in current in the field circuit results in the increase in magnetisation, with a consequent increase in voltage.

From this fact is will be readily observed that in the case of a series wound dynamo, the voltage increases as the load on the dynamo increases, and decreases as the load is decreased.

This phenomena is more interesting than useful, as a steady voltage is the thing most desired. Just consider for a moment the effect of a voltage constantly fluctuating as the load varies; any such variation would render a lighting system most unsuitable to our surroundings, and certainly most irritating to our nerves.

When we consider the case of the shunt wound dynamo we find a different set of circumstances.

The shunt winding forming an independent circuit from the external circuit. Being in parallel to the armature circuit, only that fraction of the armature current may pass along it as its resistance will permit, and as this resistance is a constant value, the current passing round the shunt winding is constant within a very small limit of variation. Naturally the magnetisation is practically constant, and as a result the voltage of the dynamo is constant within such limits. Voltage fluctuations are therefore much less noticeable in the case of a shunt wound dynamo, than with the series wound type.

It must be borne in mind, however, that we arrive at a point when no additional amount of magnetising current will increase the magnetic flux of the pole pieces, as they will have arrived at a condition of saturation. After this point is reached the conditions become stable and the voltage of both series and shunt wound dynamos rapidly decreases, whilst the energy used in continuing to magnetise the pole pieces after this point is reached, is just so much lost power.

By compounding the windings, the shunt part of the compound winding will neutralize the series part of the compound winding, and in this manner it is possible to so proportion the windings that we obtain the average effect due to both the windings, and so can obtain a steady voltage under almost all conditions of load.

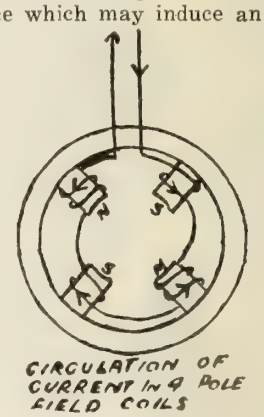
The winding of field coils is a much simpler operation than the winding of the armature, consequently whenever a fault occurs in this winding it frequently happens that the job of re-winding is given to the "handy man" around the plant.

There is one very important precaution which should be taken, which if neglected, serious damage may result to the machine, or possibly the operator of the machine.

It may so happen that the inner or starting end of the coil is brought out at the top of the coil. Let us just pause and see just what this means.

In bringing this end to the top, it must of necessity pass over a number of wires, forming the layers of wires in the coils that wind round the pole piece.

When current is flowing in this lead, there will be a certain amount of induction between it and the adjacent layers of wires, hence we are getting back to the condition required by Faraday in his early experiments on induction. When we interrupt this current flow we immediately develop a very high inductance which may induce an E. M. F.



of several hundred volts. The sudden collapse of the magnetic lines cuts the large number of conductors contained in the coil, with the consequent generation of a high voltage. It is for such a reason that an operator may receive a severe shock if this point is not appreciated by our "handy man." Unless therefore a considerable reinforcement

(Continued on page 38)

FLAME BRAND

HIGH TEMPERATURE CEMENTS

RED FLAME
PLASTIC CEMENT
WHITE FLAME
INSULATING CEMENT
BLUE FLAME
FIRE BRICK CEMENT

"MONO" TRADE MARK
REG U.S. PAT. OFF.
BOILER BAFFLES
ARE MONOLITHIC
AND "HUG THE TUBES" AT ANY ANGLE

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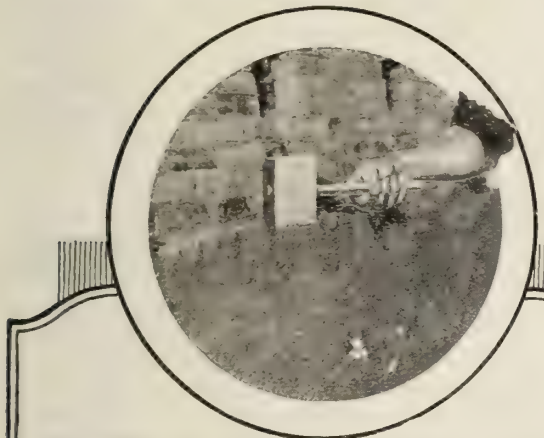

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Everywnere the mallet blows are driving home Plibrico and the idea behind it; better furnace linings that last longer and are easier to install and repair. The new booklet, "Modern Furnace Building," will start you on the road to better furnaces. Say where.

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—is delivered only in steel containers of distinctive appearance, as shown below. Warehouse stocks in principal cities. Sold by Jointless Fire Brick Co., 1142 Clay St., Chicago.
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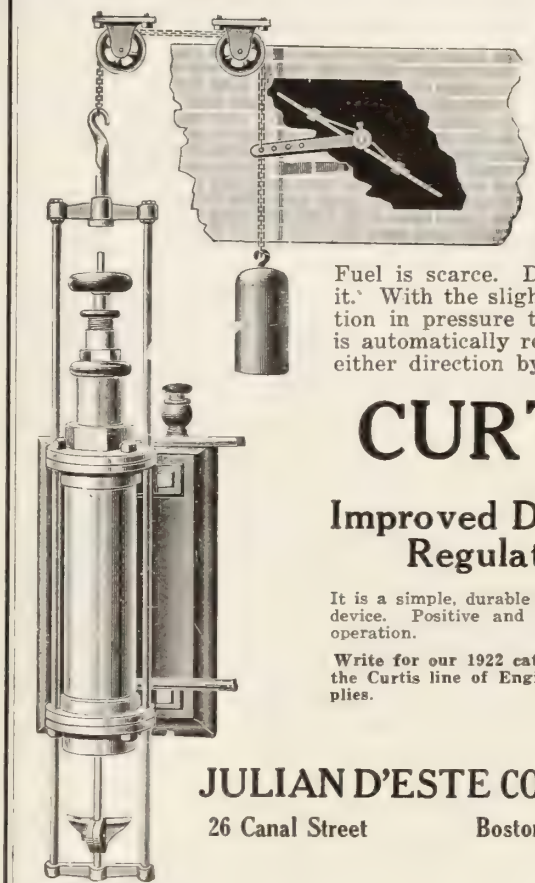

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Fuel is scarce. Don't waste it. With the slightest variation in pressure the damper is automatically regulated in either direction by the

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DESIGNING ENGINEERS AND MANUFACTURERS OF ELESCO STEAM SUPERHEATERS AND PIPE COILS FOR ALL PURPOSES.

FEED WATER HEATING EQUIPMENT FOR LOCOMOTIVE SERVICE; BOILER FEED PUMPS FOR ALL SERVICES; EXHAUST STEAM INJECTORS.

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THE SUPERHEATER CO., LIMITED,
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MADE IN CANADA
WORKS AT SHERBROOKE, QUE.

When Writing Advertisers Please Mention
POWER HOUSE — *That is Your Introduction*

PRACTICAL ELECTRICITY

(Continued from page 36)

of the insulation on this particular lead is effected, this high E. M. F. due to the inductance of this circuit will in time be certain to puncture the insulation, short circuiting the coils, reducing your magnetic field, resulting in drop of voltage on the machine, perhaps causing a fire, and in case of a shunt wound motor, probably cause it to race at a speed which may cause it to burst, resulting in wreckage to the adjacent machinery, with possible loss of life to the operators in that section of the factory.

As a kingdom was lost for the want of a horse-shoe nail, so may the above dire results accrue for the want of a little extra care over a job that is too simple to devote a little thought to.

Many dynamos are now built with smaller pole pieces inter-spaced between the regular pole pieces and these are known as inter poles, or commutating poles.

COMMUTATING POLES.—Commutating poles are not intended to actually give additional power to the dynamo; their function is really to increase the efficient distribution of the magnet flux. This flux becomes distorted, which is why the brushes on the commutator are not located in the exact centre point between the pole pieces (this point will be treated in greater detail in a subsequent article). By overcoming this distortion of the flux, the tendency to sparking at the brushes is eliminated.

These commutating poles carry a winding which is traversed by either the whole of the armature current, or only a fraction of it, as pre-determined by the designer. All such poles are much smaller in area than the main exciting poles, as they are merely for corrective purposes, and not for the actual generation of the main energy of the dynamo.

Before the advent of commutator poles the output of a dynamo was strictly limited to its sparkless condition. We now can disregard such a limit, as sparking has been eliminated by correct proportioning of the commutator poles and we are therefore only limited by the temperature rise. With ample ventilation, a high speed dynamo may be running at a current density of over 3,00 amps. per sq. in., yet be entirely free from sparking at the commutator.

The addition of commutator poles to a dynamo results in a considerable increase in the capital cost, but when considered in the light of ultimate economy it would appear to be a desirable form of investment, and providing the machine possesses ample ventilation, a greater amount of energy may be taken out of the machine.

According to Mr. Hobart, the great designer of electrical machinery, he says: "In case of 250-volt dynamos, the ordinary type of construction is cheaper for all outputs so long as the speed does not exceed [illegible] revolutions per minute; at 200 revolutions per minute, the commutator pole design is desirable for 600 kilowatts, whilst at 1,000 revolutions per minute, it is desirable beyond 250 kilowatts."

From Mr. Hobart's conclusions it is apparent he takes advantage of the higher speeds to give an improved natural ventilation, irrespective of considering the particular design. From this we can accept a general law controlling operating conditions.

Any dynamo may be safely overloaded within its safe temperature limits, and the higher the speed of the dynamo, the greater percentage of the permissible overload.

VALVE GRINDING MACHINE

A portable machine for grinding automotive poppet valves to a definite angularity and for grinding reseating cutters used for facing valve seats to the same angularity as the valve has been developed and offered to the trade recently. The machine is not of the adjustable type as it is assembled at the factory to grind at a pre-determined angle, and is therefore a single-purpose tool. The machine is driven by a Westinghouse motor which is mounted on a low, flat base. It is so located on the stand that vibration is reduced to a minimum, so that accuracy of grinding is not affected. Movement of the valve holding spindle is obtained by means of a hand lever. Feed is by a small hand wheel and screw. These tools are made by the Franklin Machine and Tool Co., Springfield, Mass.

A BUSINESS EVOLUTION

Forty publishers of morning newspapers met in Chicago a couple of weeks ago and formed an association to promote the morning newspapers' interests in competition with the evening newspaper as an advertising medium. The chief method by which they say they intend to accomplish this is through announcements in the business newspapers of the United States—that is papers of the type of Power House.

This is an interesting evolution—the recognition of the place and power of the specialized newspaper.

Montreal.—P. Ackerman, electrical engineer of the Shawinigan Water & Power Co., has perfected an invention that has to do with relay protection making long-distance transmission of high electric power safer and more effective. Much interference with service was caused by lightning, wind or sleet storms. By the new method, a faulty section is disconnected automatically. Long distance transmission has been made safer and more effective.

E. B. Eddy Co., Hull, Que., are considering the location of a branch factory at Sault Ste. Marie, Ont.

A GLUE POT WITH AUTOMATIC HEAT CONTROL

Most everyone of our readers at some time or other has had difficulty in using glue because of the great variance in the flexibility of glue mainly due to uneven heating. Glue, like most other similar substances, has a certain point of temperature where it attains its greatest flexibility and viscosity.

U. S. Government Experimental Stations have established and scientifically proven that glue is most readily applicable and possesses the greatest holding quality at a temperature of 140 deg. to 150 deg.

When glue is permitted to heat to a temperature of 176 deg. or more, it loses its tensile strength. Similarly if it is cooled to 104 deg. or less, there'll be a decided fluctuation in the strength and holding quality.

Thermostatic heat control was recommended but heretofore no one had produced a satisfactory, controlled heat, glue pot which has been fully automatic and required no personal attention.

It is claimed that the Wallace Glue Pot, equipped with a reliable, fully automatic heat control device, is filling the need in an efficient and reliable manner.

There are several exceedingly practical and interesting features incorporated in this new bench glue pot, the foremost of which is of course the automatic heat control which keeps the temperature of the glue between 140 deg. and 150 deg. at all times.—"Steam."

Exports of pulp and paper during October amounted in value to $9,897,356, of which $5,811,954 was in newsprint and $3,936,367 in wood pulp, $49,035 being in other kinds of paper. There were 1,631,043 cwts. of newsprint, and 1,147,199 cwts. of wood pulp shipped. The United States took all but 146,862,000 cwts. of the newsprint exported. As compared with September there was a falling off in the exports of wood pulp, but an increase in those of newsprint.

Clifton Mining Company, at Porcupine, Ont., have installed a steam plant as an auxiliary to electric power.

The construction of a new addition to the plant of the Howard Smith Paper Mills at Cornwall, for the manufacture of bleached soda pulp, will likely be started shortly, according to an announcement made at a directors' meeting held last week. Canadian requirements for this product have so far been imported. The new plant when completed will have a capacity of 15,000 tons per year. The soda pulp will be used for mixing with sulphite pulp to go into the manufacture of certain grades of paper.

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Can. Fairbanks-Morse Co., Ltd., Montreal.
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Waterous Engine Works Co., Brantford.

BLOWERS
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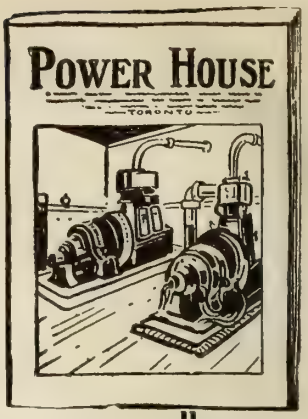

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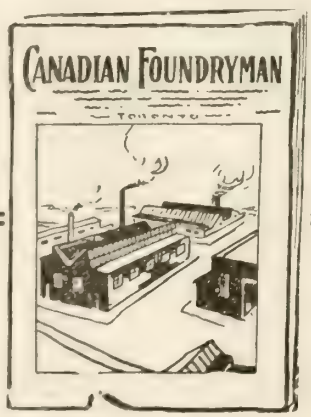

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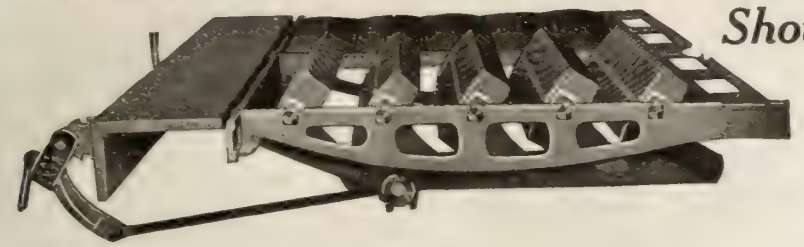

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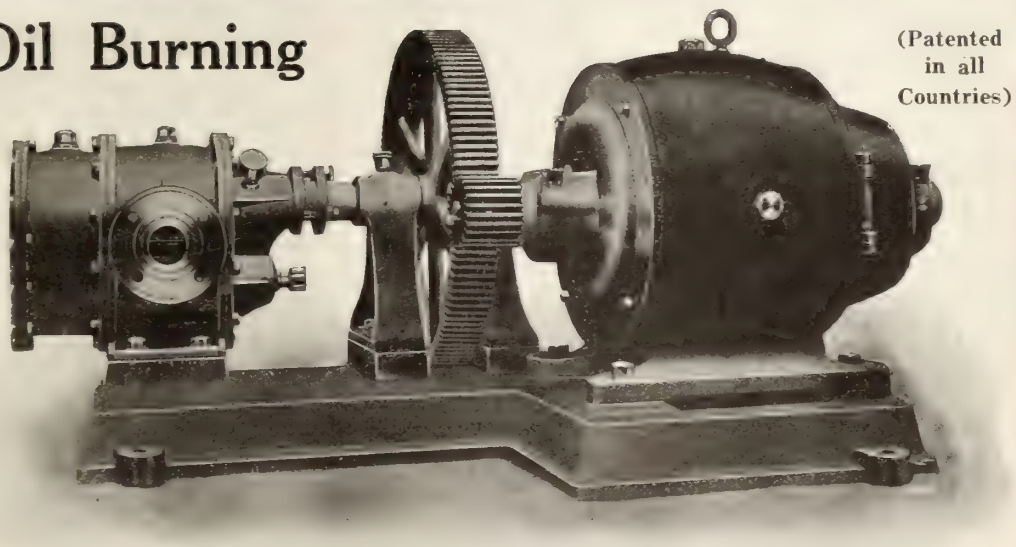

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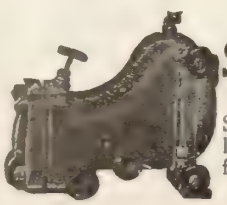

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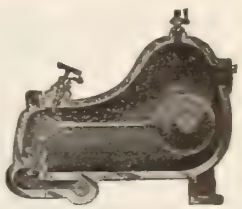

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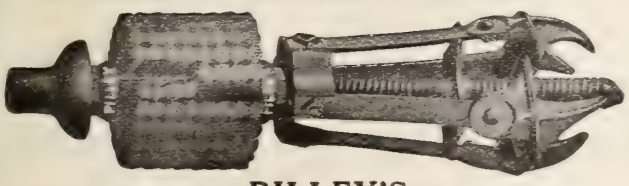

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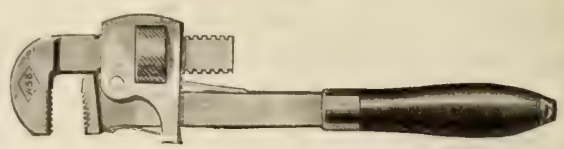

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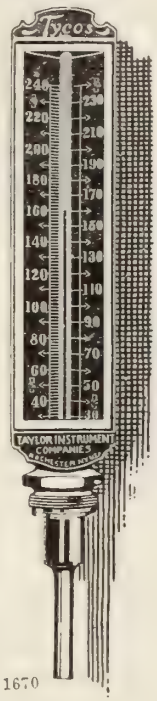

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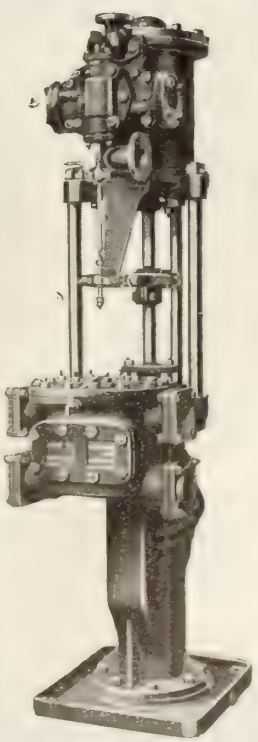

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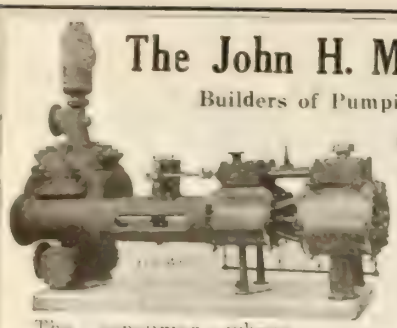

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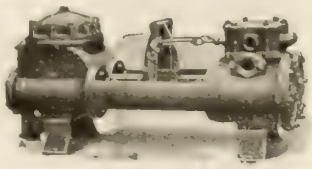

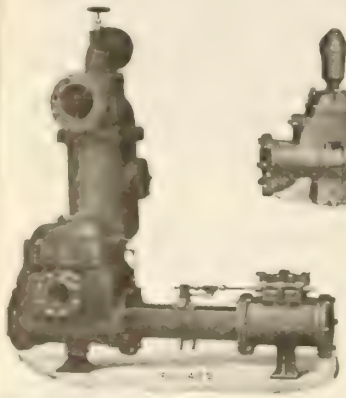

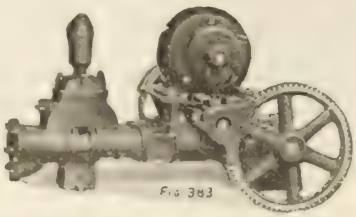

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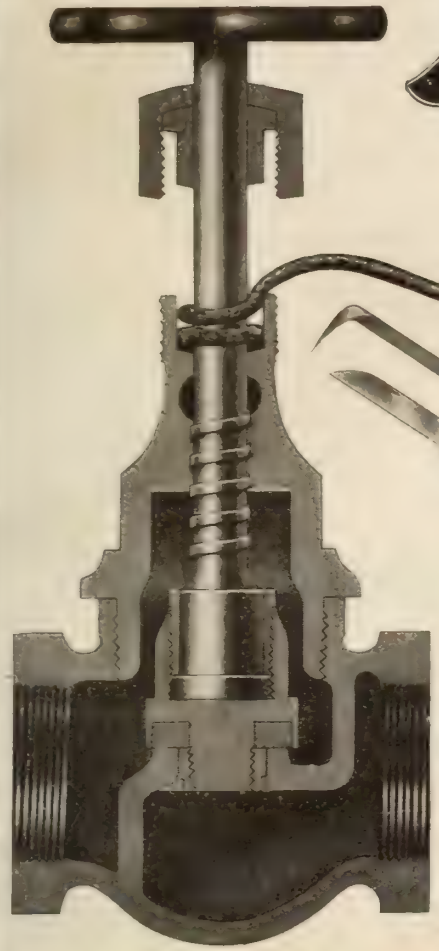

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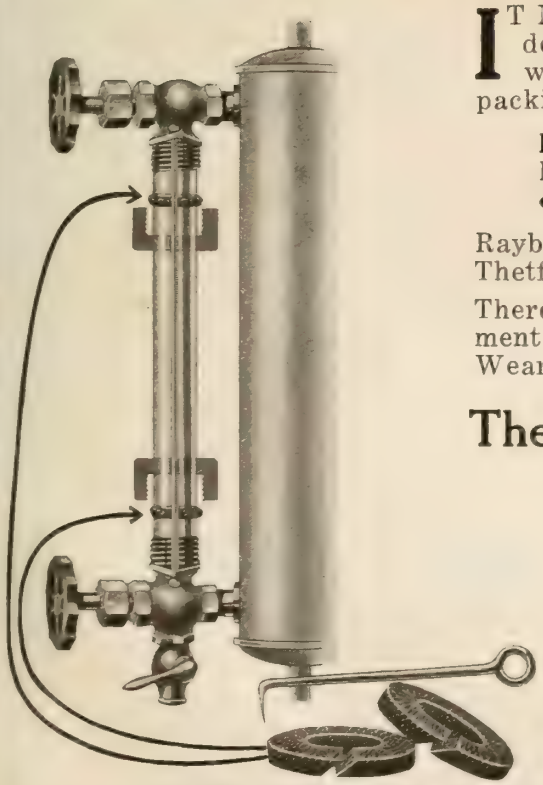

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